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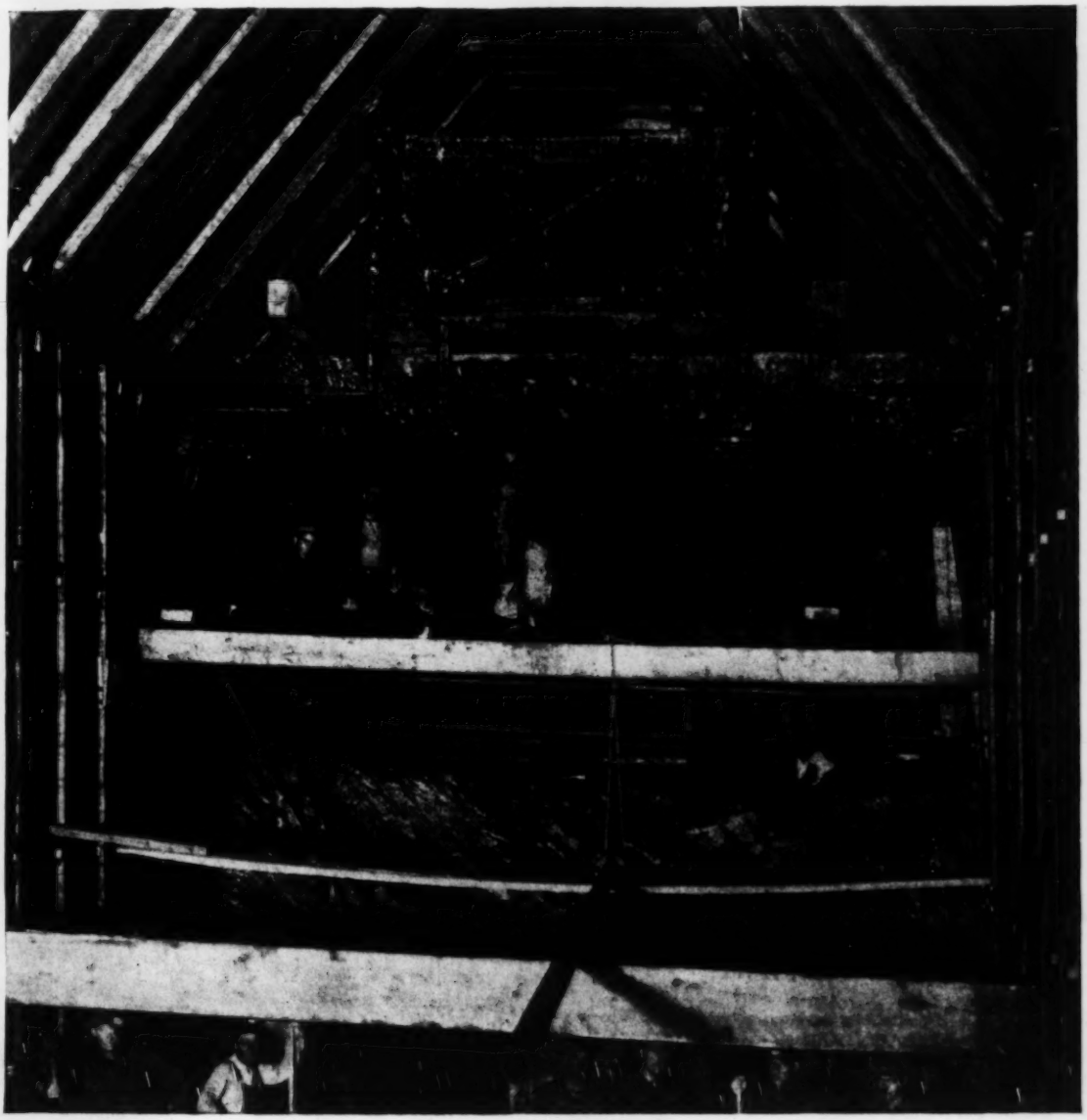
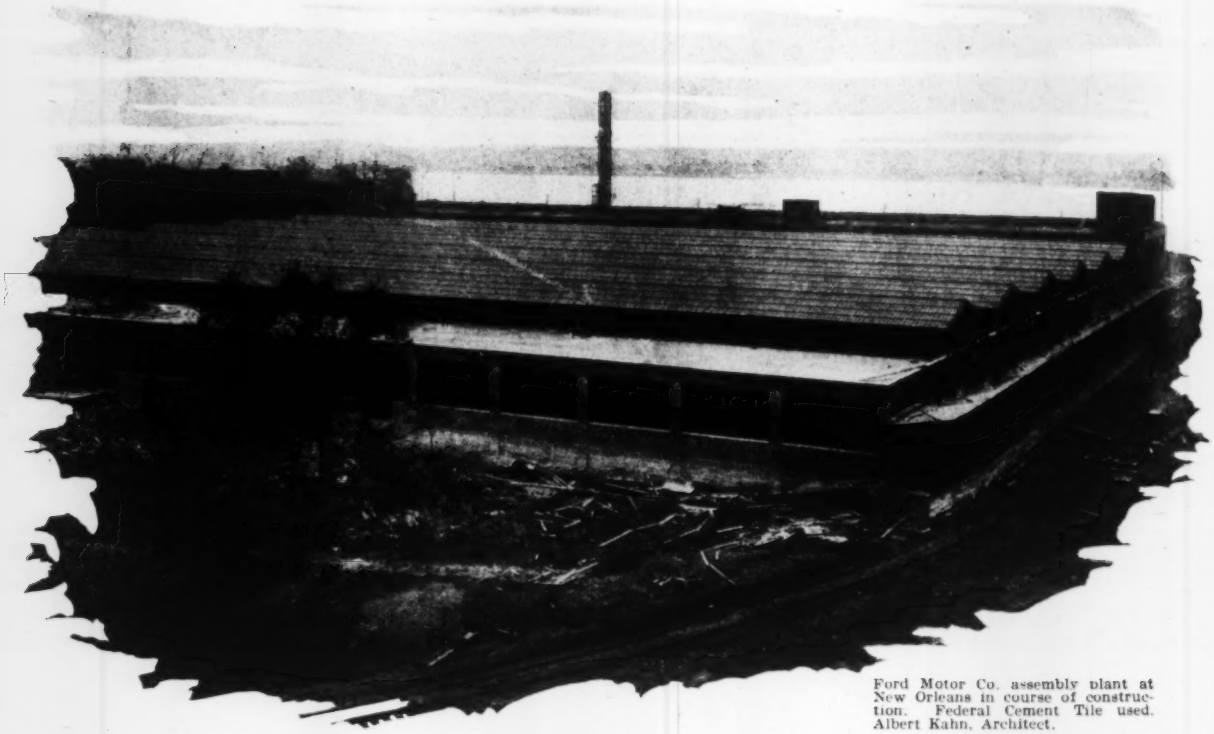


Traveling Cantilever Needle-Bar Supporting Roof Timbers in Moffat Tunnel

Construction Methods on 6-mile Moffat Tunnel—Dam and Power House Construction at Marinette, Wisconsin—Illinois Tornado Effects and Some Lessons



Ford Motor Co. assembly plant at New Orleans in course of construction. Federal Cement Tile used. Albert Kahn, Architect.

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Frank C. Wight
Editor

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A.A.E. Saved From Shipwreck

FOR a moment, danger that the movement toward professional unity represented by the American Association of Engineers might end in shipwreck has been averted. The past year was one of unrest and discouragement within the organization. There were conflicts and suspicions, which finally became so exacerbated that many members feared early disintegration of the association. It seemed almost that the impetus of constructive purpose which gave the association life had come to an end. But the delegates to the convention came together with strong and sincere desire for harmony, and as the report on p. 980 indicates they succeeded in bringing it about. The association has been in dangerous shoals. No one can say with assurance that they are safely astern. The future depends on able helmsmanship and loyal aid of the entire ship's company.

Aid the Veteran's Bureau

ATTENTION is called to General Hines' plea, on another page of this issue, for the employment of the numerous rehabilitated veterans of the World War whom the government has been educating as engineers and training for various positions in the building industry. No more necessary obligation is imposed on the nation than to see to it that those men who suffered by their services in the great struggle should be put in the way of earning that living the War would otherwise have denied them. The government has done its part in fitting these men for industry. It is now up to the individual citizen to do what he can to utilize the material the government has helped to make. Any engineer or contractor who is in need of elementary help will be performing a patriotic duty in utilizing this potential material the government has to offer.

A Great City Engineer

FEW city engineers have done more to fix the impress of their office upon the public works development of a municipality than did George H. Benzenberg. No mere scheduling of the material improvements which he brought about accounts for this. It is not explained by the undoubted technical skill of the man. True his office gave him wide authority. It made him not only the city's engineer but the manager of its water department and the president of the board of public works. But even this breadth of authority and duty much greater than is given to most city engineers is not the reason why city engineering in Milwaukee was dignified beyond the common custom of the day. Neither did it lie wholly in the high ideals of the man. Other city engineers had ideals quite as lofty. It lay in the blunt common sense of one who knew that public influence was required if ideals were to be carried through and who went purposefully at work to create and direct that influence. He did not turn to political jockeying. Indeed politics as it is commonly defined was kept very far from the functioning of his office. Instead the power above the politician was reached to for aid—the interest and public spirit of the city's financiers, merchants and industrialists. Once these forces found their confidence justified they backed the city engineer again and again in his battles for public improvements. Of course integrity and force and grit had to be in the man to get such recognition—and they were and he was fortunate in the possession. It cannot be grasped by all. But while it is given to few city engineers to do what George H. Benzenberg was able to do for the credit and dignity of the office of city engineer in Milwaukee, they can salute his passing spirit as one which accomplished a giant's work in commanding recognition of and respect for the position which they serve.

Teacher of Men

ANOTHER great engineer passed away last week. No great structure, no great project is a monument to Mansfield Merriman's right to that title; his fame rests in the successive generations of young engineers who came under his tutelage at Lehigh or learned the fundamentals of their profession from his books. He was one of the first and of the greatest of our latter-day engineering teachers, but he had more than the ability to instruct by word of mouth, he had the great and rare ability to set down principles for the uninformed in lucid and explicit style. Only a few weeks ago in these pages Clemens Herschel told how the young Merriman not only developed the theory of least squares for the use on a bridge triangulation a half-century ago but how he later turned that development into a textbook for the use of others. Many engineers would have been able to work out the principles of that theory for their own use; it was the rare one in those days who could see the need of the transmission of that knowledge to the coming engineers, and who could, besides, satisfy that need. To have had that faculty and to have exercised it is as secure a claim to the engineering laurels as to have designed the Brooklyn Bridge or to have dug the Panama Canal.

A Measure of Society Activity

IT IS most interesting to observe, in reading the list of current researches in materials given on p. 976 of this issue, that an organization with a brilliant record of productive activity concerned solely with existing knowledge, a society which at the same time is noted for its broadly polytechnic membership and for the energetic co-operation of the interests it unites—the American Society for Testing Materials—is at the same time the fostering agency of extensive research work. The coincidence tends to confirm the opinion of many, that there is a close relation between society vitality and research activity. Research springs from an intelligent perception of the shortcomings of knowledge in the field of joint interest, and is activated by the desire to improve this knowledge. Obviously, the same factors contribute to the general vitality of a society's

existence. However, in appraising the meaning of research activity account must be taken of the factor of opportunity. Not many technical organizations have such broad opportunities presented to them in their current work as the American Society for Testing Materials. Yet it is pertinent to recall that this society has within the past year entered on a campaign to expand its research activities even beyond the range represented in the list we publish. Such research as has developed hitherto has been mainly that which was the immediate corollary of committee work on purchase specifications and acceptance testing—both related to the commercial requirements of production. The proposed work is independent of production and commerce. It was planned in recognition of the fact that knowledge of materials, if it is to grow most favorably must be sought outside as well as within the range of commercial production. This recognition is in itself testimony of well directed purpose.

Saving Money on Dinkeys

LIGHTWEIGHT high-powered locomotives have made quite a difference in the problem of design of certain kinds of pioneer construction plant. Engineers will remember photographs taken years ago showing a contractor's dinkey being lowered by cableway into the excavation for a dam footing; such pictures were fairly common for such structures as the Strawberry Dam, for instance. These engines weighed twenty to thirty tons, possibly, and the whole handling equipment had to be designed accordingly. Today similar tractive power can be had in a locomotive weighing a third as much, and of a compactness and ready speed control unknown to their clumsy predecessors. More effort is being put on the design of such locomotives by the manufacturers and more care in their selection by the contractors. The handling equipment, the trestles and the trackwork consequently benefit economically. On the Exchequer dam, for example, an 8-ton gasoline locomotive is efficiently handling two 25-ton gravel cars on a 1-per cent grade. It was not so long ago that a contractor would have been using a discarded "dummy" off the New York elevated—and his whole plant would have shown an appreciably increased cost because of this relic.

Moffat Tunnel Lessons

THE longest railway tunnel in America is the Moffat tunnel now being driven some fifty miles west of Denver in Colorado. Length alone, then, gives the new tunnel prominence as a construction task, but its more impressive claim for attention is that it illustrates very nearly the sublimation of mechanical rock tunneling equipment, and at the same time its nearly complete nullification, by natural conditions. In the dense rock of the east headings and enlargement, all operations were by machine, but at the opposite end where the rock squeezed and fell only the air drill and the muck car remained of possible use. The mechanical mucking and the ring drilling, both unusual features of the east tunnel, gave way to the methods of heading and bench drilling and hand mucking practiced from the first days of the power drill. Only the perfection of the drill and rolling stock is greater and the motive power is different. Withal this warning of the limitations of machinery in tunnel work the Moffat tunnel is a striking example of the possibilities of machine operations in rock tunneling. There have been few more perfect examples of co-ordinated equipment schedules than the one presented by the operations in the east headings. The article in this issue gives the facts. It also points out the important function of the parallel service tunnel in cutting down construction time. This is an unusual service device in American tunnel building and perhaps might not have been adopted at this time had not its ultimate use as a water conduit been in prospect.

A National Problem

IRRIGATION problems and achievements are to be discussed at the Salt Lake meeting of the American Society of Civil Engineers next month. The subject is ideally suited to place and time—to the spot where Brigham Young's emigrants engaged in their heroic attempt against great odds to wrest a livelihood from the arid Basin slopes, where they laid the foundation of modern irrigation; and to the time, this year of 1925, when irrigation development throughout the West looks into a future of discouraging hazards and difficulties. Profound changes have come to pass in irrigated agriculture since the days of the Mormon migration. The technical and agricultural problems that were primary in that early period are now overshadowed by the economic problems of working out large agricultural colonizations to a financial success despite the handicap of forbiddingly high first cost. These latter problems well deserve to engage the attention of engineers, as of all men interested in the further growth of our country and the best utilization of our national wealth. And while presumably the meeting will give study mainly to the technical or constructional side of the subject, it will have directly before its eyes the scene of one of the greatest of present-day development projects, one in which the matter of economic practicability is the crucial factor. The meeting thus creates an opportunity for bringing to better understanding certain questions whose proper answer remains to be discovered.

Study of Tornado Effects

THE engineers who went down to southern Illinois to see the destruction done by the great March tornado and interpret its effects in structural terms have done a notable thing in rendering the report summarized in this issue. They have made a basic contribution to human safety and improvement of our constructions with respect to these tremendous storms. Their work is at best a fragment, being an interpretation of the difficultly legible record of a single tornado; nevertheless it is a pioneer contribution, that in time should lead to such an understanding of the powers of tornadoes as will enable man to escape from or protect against their destructive powers.

Meteorologists have given close study to tornadoes for many years, yet their efforts do not seem to have been of much help in furthering protection of life and property. Where the meteorological observer is concerned with velocities, pressures and isothems, the structural engineer on the other hand studies force and energy effects. And these in turn make direct contact with the problem of how strong to build.

Strange and confusing happenings occurred in the tornado-swept region, as in other regions in other tor-

nadoes. The observers have recorded many terrifying exhibitions of power. Their calculations indicate very large forces, so large that it appears out of the question to build *all* structures to resist them. Throughout, the report opens up many more questions that it answers. Yet its positive value is unmistakable.

Tornado effects are so largely unexplained and unexplainable that they are a more fruitful field for the exercise of imagination than for the application of numerical calculation. Yet we must make progress through calculation, and discount and distrust all fancies, however plausible.

Almost everywhere in the path of the storm, effects of utmost violence appear close beside exhibitions of resistance that suggest relatively moderate forces. We find projectiles driven through trees and walls, and only a few feet away frail structures left almost uninjured. We find two neighboring structures, the stronger destroyed and the weaker surviving. Concerning every fact and datum of the storm, it may almost be said, comparison or collation with other facts and data is impossible without risk of serious error. The tremendous velocity effects present in tornadoes are of quite unknown size, but it may well be, on the evidence of some of the facts, that they are of small areal extent, mere filaments of extreme velocity in the general swirl of the air currents. At any rate in the present tornado no force actions of large area have been evaluated at such exceedingly great figures as would correspond to observed projectile effects. Amid these confusions and contradictions progress necessarily must be made by chance steps rather than by system.

Such a chance step constitutes the most important yield of the Illinois storm study, as expressed in the conclusions of the engineers. Briefly stated, it is that the most disastrous failures in the storm path were due to or were aggravated by faulty construction. Bonding, anchorage and bracing were neglected. Included among the defects is the inadequate construction of the roof of the high school gymnasium in Murphysboro, where the heavy steel roof was set on high walls like a heavy table top on rickety legs—an expression of optimistic hope that nothing rude or violent would come along to push it over. School architecture, in fact, made here a definite record of disgrace.

Clearly, the architectural and engineering practices of quieter regions are not suited to the tornado belt. Rule-of-thumb architectural construction is out of place in any public building, but most of all in regions where these intense, unaccountable storms may occur. We have not yet progressed to the point where complete calculation can be applied to making buildings proof against tornadoes, and the data on which to base such calculations are as yet only highly speculative first guesses. But, pending further progress, we have some substantial reasons for concluding that the most solid and thoroughly braced portions of these buildings were inherently strong enough to weather the worst violence of a Mid-West tornado, while the weaker portions were far too weak to survive. We may fairly conclude, then, that a very great increase in public safety may be secured by avoiding the local weaknesses exhibited in these structures, by tying them together thoroughly, by carrying the main elements of framework through to a substantial foundation with adequate anchorage, and in general by making the entire structure integrally as strong as its best built and strongest parts.

There is some opportunity, also, though concededly less complete, for improvement in ordinary frame dwelling-house construction. Here also anchorage, tying and bracing are of controlling importance. Until the efficacy of frame construction properly provided with such safeguards is tried out by storm, it is futile to endeavor to conclude with positiveness either for or against the inherent risks of the type of construction.

Tornadoes are not irresistible, as many people fatalistically believe. Through the study of tornado effects we will learn how much strength must be provided to resist them. The present report is a beginning. Ultimately it should be possible to compile a consistent body of data ranging over the whole field of tornado action, if the present beginning is taken as an example by structural engineers throughout the world's tornado areas and encourages them to seize whatever opportunities may come to them to carry out similar investigations.

Neither Immoral Nor Illegal

MANY users of cement have in their minds, vaguely or definitely as the case may be, that the manufacturers of cement some years ago were charged with, and convicted of, illegal practice in the restraint of competition. Most people fail to draw a line between illegality and immorality, so ever since the current manufacturer's case in New York, three years ago, there has been a taint of immorality around the whole cement industry. In fairness to that industry it is to be hoped that all who have been harboring these ideas will read and digest the Supreme Court's decision exonerating the cement manufacturers in the East (who were the specific ones restrained by court action). For that decision makes clear that legality is a matter of interpretation and that its relation to morality is quite tenous.

In the opinion of the majority of the court there is nothing illegal in the attempt of a group of producers to learn all they can regarding the underlying conditions of their industry, even though the independent possession of that knowledge may result in a uniform price of their product. Illegality rests only in the collusive fixing of price. Further than that the decision goes to some pains to explain that there is nothing essentially wrong or immoral in a group effort to discover as much as possible of the basic facts regarding the business of that group. This is in effect the contention of those who believe that in the fullest knowledge lies the hope of industry, that for individuals to work alone and in the dark tends toward cut-throat competition that may result in momentary reduction of price but which must in the end delay economical production and prevent its fullest exercise.

It is good to have this doctrine affirmed by our highest court, for it shows that progressive thought can penetrate the forests of legalism. But it should also persuade some people who have held different views that what the cement manufacturers were doing was not essentially iniquitous, but was an effort to carry on their business as efficiently as possible. One need not be so innocent as to assume that these same manufacturers were not anxious to get as fair a profit as possible out of their business. They are, after all, only human. But there is no evidence that what they did unduly raised the price of cement to the consumer, and that is the criterion of the immorality of their actions.

Construction Methods on Six-Mile Moffat Tunnel

Parallel Tunnel With Cross-Drifts to Main Tunnel Takes Care of Haulage and Other Services—Squeezing Rock Called for Unusual Timbering Methods

DRIVING a six-mile railway tunnel in rock is by any criterion a notable task. In driving the Moffat Tunnel the task is further distinguished by the employment of special methods and unusual equipment. A parallel service tunnel is provided the entire length of the main tunnel. Squeezing rock at one end has demanded unusual timbering methods in enlarging the pilot headings to full section. Speed requirements have made necessary the highest perfected electric and compressed air excavating tools and haulage system. Isolated location and a severe climate impose a heavy duty in adequately housing workmen and in preserving their health. In all, conditions required the very last proved devices provided for the tunnel builder. Their adoption is the distinctive construction characteristic of the great tunneling operation by which Denver will bring Salt Lake City and the Pacific 173 miles and a quarter of a day closer.

The Moffat Tunnel

The six-mile Moffat tunnel in Colorado is unique in conception plan and methods of construction. Its history and plan were outlined in "Engineering News-Record," Dec. 13, 1923, p. 962. Articles on progress and special construction devices have since been published in the issues of March 6, 1924, p. 402, Aug. 14, 1924, p. 279, and March 5, 1925, p. 403. Progress now has reached the stage where a coherent story of construction can be told. It is presented here as observed in a visit to the operations from both portals and as recorded in picture and plan by the men who since the first have directed operations.—EDITOR.

The Moffat Tunnel is being constructed under James Peak of the continental divide to cut out the loops in the Denver & Salt Lake R.R. as shown by Fig. 1. As stated it will shorten the railway distance to Salt Lake City by 173 miles and, what is of more import, it will eliminate the 4 per cent grade of the 30-mile mountain division on which now some 40 per cent of all operating costs are spent for fuel and for fighting snow. Beginning one-half mile west of mile-post 50 west of Denver, and at El. 9198, where the grade of the railway changes to 4 per cent, the tunnel extends west on an ascending grade of 0.3 per cent, 14,708 ft. to an apex and then on a descending grade of 0.9 per cent 17,452 ft. to El. 9085 at the west portal, near mile-post 80 west of Denver on the Fraser River.

From these figures the total tunnel length is 32,160 ft. Its section is the usual 16x24-ft. single track railway section, as shown by several of the drawings. This section gives about 365,000 cu.yd. of rock excavation. The paralleling service tunnel and cross-cuts add about 157,000 cu.yd. of rock excavation. Both tunnels require about 1,160,000 ft.b.m. of timbering. Perhaps 35,000 cu.yd. of miscellaneous excavation and 5,000 cu.yd. of concrete masonry complete the main tunnel construction quantities excluding railway track. Excavation and timbering then are the controlling volumes and accessibility of location affected only getting in the lumber for timbering.

As the location map Fig. 1 shows, the tunnel portals were not far removed (about a mile at each end) from the main line railway, and short spurs gave direct railway service to the portal plants. This location, however, was enough removed to call for complete independence of the railway towns for housing and boarding workmen by providing complete self-contained portal camps. The next requirement, power service, was also conveniently met by building a 30-mile power transmission line to the east portal from Boulder, Colo., and contracting for 1,000 hp. of 44,000-volt current from the Colorado Power Co. Access, then, in the matters of providing housing, transportation and power services did not offer notable difficulties. The difficulties were rather those of construction proper. As bearing on construction methods the contract conditions need be mentioned only in respect to the rapid construction time of 46 months. A somewhat extended summary, however, can be found in the preceding articles to which reference is given in the introductory note.

Construction Plan—The outstanding feature of the construction plan is the parallel service tunnel. This is a familiar construction device in Europe for long rock tunnels but its use has not been common in America. Its adoption here was, from the construction aspect, to increase the driving speed, a big economic factor, by furnishing a separate passageway for service conduits—ventilation, compressed air, water—and for haulage. Also the plan contemplated its use ultimately as a conduit for water supply to Denver from the Fraser River. As the whole improvement is being conducted as a district improvement enterprise in which Denver is the major paying unit the economic value of the service tunnel is raised above its usefulness as a construction device. It is the latter service however that is of concern here.

As shown by the part plan and the section in Fig. 2, the service tunnel parallels the main tunnel 75 ft. away on the south side. Its section is nominally 8x8 ft. and its bottom is 7 ft. above the bottom of the main tunnel. Virtually it is on a grade elevation with the pilot heading of the main tunnel although at places for construction reasons the pilot heading has been carried along higher up than the plans show. Also while both service and pilot headings are nominally 8x8 ft. the contractor has dug them 9x9 ft. to get the extra working room. About every 1,500 ft. the service tunnel is connected by a cross-cut with the pilot heading. In general, however, the cross-cuts have been run obliquely instead of straight across as shown by the drawings. These cross-cuts give several points of attack for working forward and back in enlarging section and to some extent in driving the pilot heading.

The general plan of tunneling is clear from what has

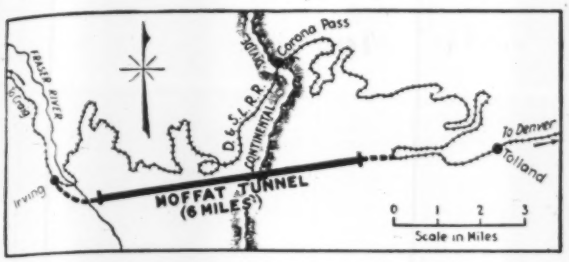


FIG. 1—LOCATION MAP OF MOFFAT TUNNEL
Six miles of tunnel cut out the loops in the Denver & Salt Lake City R.R. and eliminate about 40 miles of 4 per cent grade.

been said. A pilot heading is driven and then enlarged by ring drilling or other method. Both heading and enlarged section are timbered as required and the final timbering remains as lining. The details of driving headings and enlarging section are best presented separately. A factor which applies to both, however, is the rock characteristics. These are different at the two ends. At the east end the rock has been solid gray granite-gneiss, with intrusions of schist, and has given very little trouble from falls, slides or squeezes. At the west end, however, the granite-gneiss and schist are broken by talc seams, disintegrated and under pressure for some 7,000 ft. in, when they become hard and stable.

In summary then the general construction plan is: (1) From both ends advance a parallel service tunnel with cross-cuts to the main tunnel; (2) start the main tunnel by a pilot heading and enlarge the heading to full section working back and forward from the cross-cut adits; (3) place all service conduits in and do all hauling through the service tunnel.

Driving Headings—Heading embraces both service tunnel and the main tunnel pilot drift. At the east end the drilling and mucking crews alternate between the two, the mucking crew being in one heading while the drill crew is in the other. In each heading, each shift, a round is drilled, blasted and mucked out. Each round is 8 or 9 ft., and three shifts a day are worked. The advance per day in each heading is then about 25 ft. Fig. 3 is a hole diagram of a heading round as at the east end.

This schedule of work calls for very close co-ordination of crews and outfits and is true only of the east headings. In the bad rock of the west headings alternate drilling and mucking in each heading were followed, as is described later. At the east end a heading outfit consists of a drill carriage which alternates between service and pilot headings and of a mucking machine in each heading. Both devices were illustrated in *Engineering News-Record*, March 5, 1925, p. 403. Their importance needs to be emphasized, however.

The carriage carries four drills in the familiar manner on swinging arms. It travels on the mucking tracks and is so shifted through the nearest cross-cut from heading to heading. At the face the carriage is blocked up, the cross-arm fixed and the drills adjusted in 12 to 15 minutes. A flat car behind the carriage carries tools and hose for the setup and for making the water and air connections. A crew consists of four drillers, two helpers, one nipper and a foreman, and on regular schedule a round of 24 holes is drilled and shot in 3½ hours. The steels used are: 2½-in. for 3 ft., 2¼-in. for 5 ft., 2-in. for 7 ft. and 1¾-in. for 9 ft.

All mucking is done by Conweigh muckers (Fig. 7). These machines dig by running ahead and backing away from the muck pile, thus loading and freeing the shovel. One car is loaded at a time, as the machines discharge by belt conveyors directly back of themselves, hauling and pushing the car as they push the shovel forward into the material and back away to free

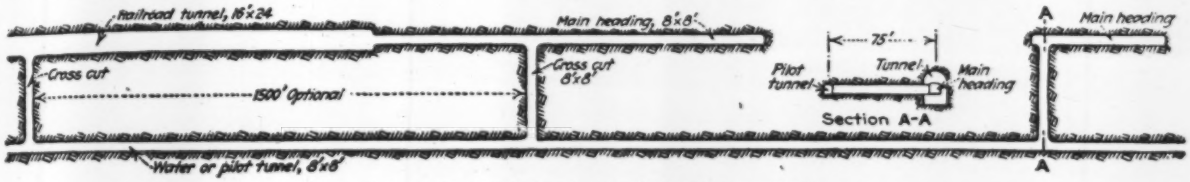


FIG. 2—PLAN OF DRIVING MOFFAT TUNNEL
A parallel service tunnel handles all excavation and service conduits and cables leaving tunnel heading and section enlargement clear for construction operations.

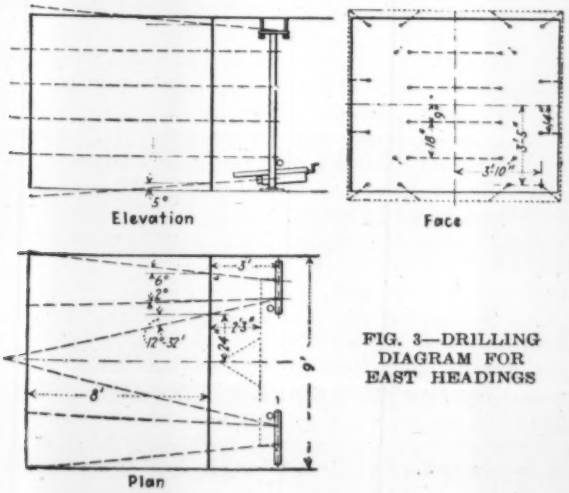


FIG. 3—DRILLING DIAGRAM FOR EAST HEADINGS

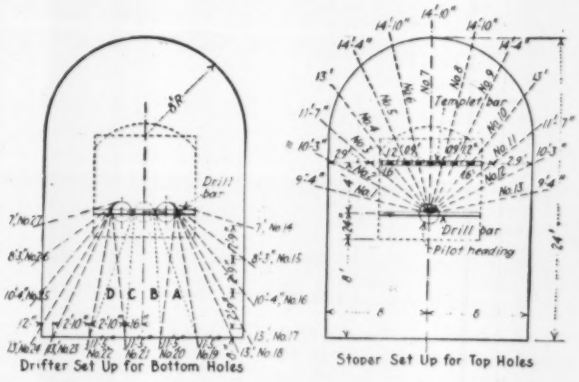


FIG. 4—RING DRILLING DIAGRAM FOR ENLARGING SECTION

the shovel and take a new position. When a car is filled it is shifted back and replaced by an empty car until a train is made up to be hauled away as described in a succeeding section. In the regular east-end schedule, a round is mucked out in four hours, with a crew of one operator, three muckers, one motorman, one brakeman and one scaler.

Excepting for an occasional loose schist seam no timbering of the east heading is required. The west headings have been timbered generally by square sets kept as close as possible to the face, using poling boards held by booms cantilevered out from the erected sets to hold the roof until the muck could be removed and posts set up. In the very bad rock the heading was raised to near the top of the cross-section so that enlarging section could be done in two or three lifts as later described. In substance the heading driving plan and outfit in the west end bad rock were to muck by hand into cars and to drill from tunnel bars beginning as soon as enough muck had been cleared from the top to permit a drill setup. With the bad rock section passed, change will be made as nearly as practicable to the plan and outfit used at the east end.

In summary, machine tunneling is planned to the practicable limit in driving the headings of the Moffat tunnel. This and close co-ordination of operations have produced high speed. It is important to note some of the factors. The drilling machines make possible (1) by their mobility, quick shifts over considerable distances so that one outfit serves two headings; (2) the shifting, setup and serving as a unit of all the drills (four) for a heading round of 24 ft. holes. Mucking likewise is a one-unit operation—only the cars are changed as one after another they are loaded. After a shot is fired and the smoke cleared the mucking unit (mucker with car behind) runs up to the muck bank all set for work. It loads a 50-cu.ft. car in 1½ minutes; it is regularly loading 14 cars an hour. Weight and size prevent quick shifting from heading to heading so there is a mucker for each heading with a spare machine to substitute in case of accident or lay-offs for repairs. For each pair of headings there are two drilling machines and three mucking machines and one driller and two muckers are on duty three shifts a day.

Enlarging Section—Rock conditions required quite different methods of section enlargement at the two ends. The east end operations in firm rock will be explained first. Here, with the centrally located pilot heading, "ring" blasting was adopted. Fig. 4 shows the setups for ring drilling. The floor is drilled with drifters ordinarily from two setups on the bar but in case steel cannot be changed from the side positions a center setup is used to drill holes *A*, *B*, *C* and *D* in place of holes 19 to 22. The down holes are spaced by a disk. Stopers are used for the arch holes. The setup is at the center of the bar and a templet bar gives the spacing. A slight lift is given the holes. Usually three sets of drill bars are set up at a time, but they may not all be drilled from at the same time. The spacing between rings is 4 ft., and from 3 to 5 rings are shot at once, using delay exploders so that the bottom holes break ahead of the roof holes and each ring breaks against an open face.

Blasting is done with 40 and 60 per cent dynamite, the lighter powder being used where the rock is easy. For safety in firing, which is done by the regular 250-volt current using 50 amperes, the switch box is located well back and locked and only the shifter has the key. Primers are made up at a primer house outside and well away from the portal, where a small amount of dynamite is kept, the main magazine being about half a mile away.

Mucking at the east end is by steam shovel loading cars as shown by Fig. 5. The shovel has a ¾-cu.yd.

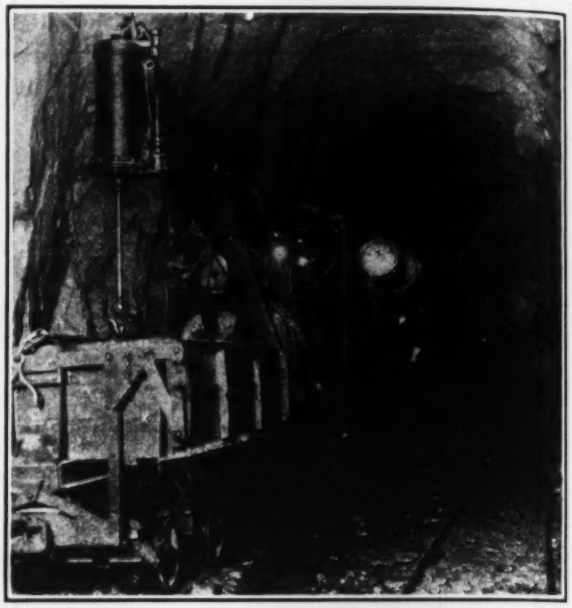


FIG. 5—AIR SHOVEL ENLARGING SECTION

dipper and is air-operated at 105 lb. pressure. It is truck-mounted to operate on 3-ft.-gage switch track. Empties run up onto the switch behind the shovel are transferred to the loading track by a 12-in. air hoist hung from the rear of the shovel, as shown by Fig. 5, on an A-frame and 12-ft. swinging boom. The cars are 4 cu.yd. and the transfer from switch to main track is made in less than a minute. In an 8-hour shift, 40 to 50 cars are usually handled but as many as 100 have been shifted. It is the plan to keep a 100-ft. to 150-ft. muck pile and also to keep the pilot heading well ahead of the full-section work so that the shovel may keep going and so that heading and enlarging operations may not interfere. Two shifts daily are worked, enlarging section.

Section enlargement at the east end was on the whole a comparatively straightforward operation—the rock was firm and broke out nicely to section. Conditions were quite different at the west end. Here geologic action had crushed the rock formations and for some 7,000 ft. in from the portal the rock was blocky, disintegrated and shifting and required hard fighting to timber and hold; methods had often to be the invention of the moment. In general there were two distinctive plans of enlarging section at the west end: (1) Side cutting the pilot heading to full width and then removing the bench in one cut; and (2) widening the heading and then taking out the bench in two lifts. The ring drilling method of the east end had no place.

Prior to describing the two methods it is important to revert again to the rock pressures. These were so great that time and again 12x12-in. Oregon fir side

posts set scarcely a foot apart were bowed to the breaking point. These pressures were greater as the rock was worse in some places than in others. Keeping this irregularity in mind will make clear the shifts in timbering practice from place to place. In general two practices cover the one-bench-cut method and one practice the two-bench-cut method. About the same process of widening heading was followed in both methods.

FIG. 6—WIDENING OUT THE MAIN HEADING WITH 5-SEGMENT ARCHES OF OREGON FIR
Storage battery locomotive in center, air and ventilation pipes on right in west portal.

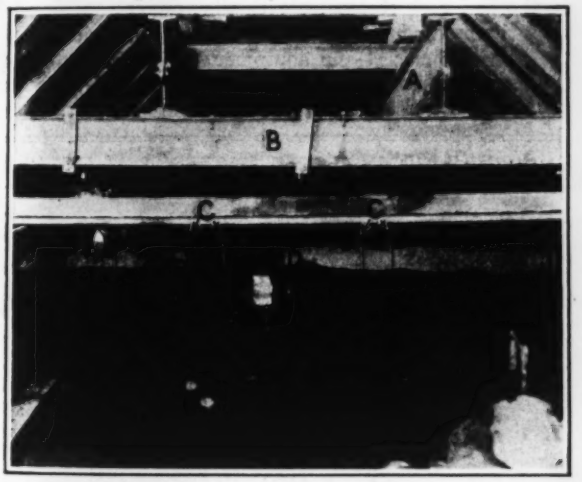


FIG. 8—NEEDLE-BAR METHOD OF SUPPORTING WALL PLATES WHILE TAKING OUT FULL BENCH
The longitudinal I-beams were supported on two transverse I-beams, doubled and telescoped, resting on the wall plates. Stirrups supported the I-beams under the unsupported section of wall plates.

In bad rock the pilot heading had been elevated to the top of the tunnel section, as previously stated. It was timbered with square sets, cap and side posts generally of round timber, spaced about 3 ft. or less apart. The plan was to widen out the heading by side cutting outside the posts and put in a timber segment roof. A three-segment roof was used normally, but in the worst rock the number of segments was changed to five; the latter construction is shown by Fig. 6. Widening out was the usual detail process using temporary bracing of suitable sort to hold the segments until a full set was completed and footed on the wall plates resting on the bench rock, as in ordinary work.

After the heading widening, a full bench cut was used for only about 418 ft. The problem was to hold up the roof timbering until the bench had been removed so that side posts could be set. The first method was named the needle-bar method and is shown in operation by Fig. 8. Two 24-in. I-beams *AA* spanned the length of bench to be taken out, usually about 15 ft. or five

FIG. 7—MUCKER IN WATER TUNNEL AT HIGH WATER

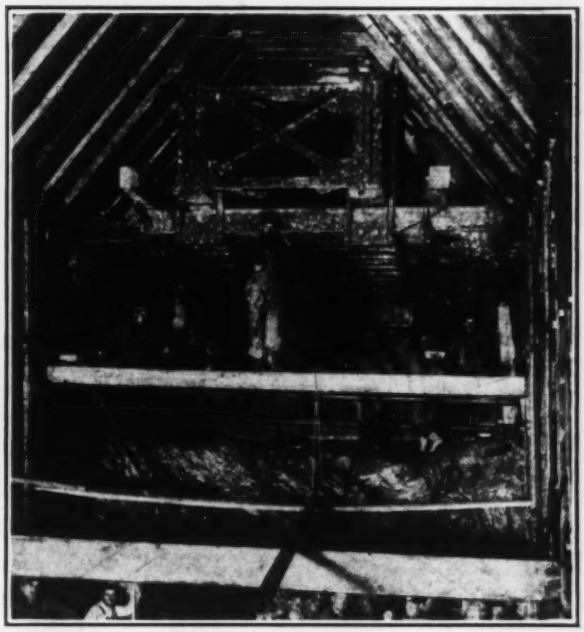


FIG. 9—THE TRAVELING CANTILEVER NEEDLE-BAR SUPPORTING WALL PLATES AND ROOF TIMBERS
Cross-arms consisting of I-beams with hangers support the wall plates. The cross girders rest on timber cribbing on the bench and overhang from 10 to 30 ft.

3-ft. bents. The beams were 40 ft. long. They were carried by two 12-in. transverse I-beams *B* doubled and telescoped. These beams rested on the 12x12-in. timber wall plates at the rear where the wall plates were on the completed side posts and at the front where they still rested on the bench rock ahead of the 15-ft. length of bench to be taken out. To carry during excavation the 15 ft. of wall plates spanning the cut, 1¼-in. rod stirrups *CC* carried telescopic transverse I-beams *D* extended under the wall plates. This method failed when the squeezing rock began to bend in the side posts. In its place a so-called traveling cantilever

needle bar devised by George Lewis, general manager, Moffat Tunnel Commission, was substituted.

As shown by Figs. 9 to 11, the new device consisted of two parallel 48-in. plate girders 60 ft. long braced 6 ft. apart. This structure rested on the bench on blocking, which formed a track for shifting it longitudinally, so that its end cantilevered 10 to 30 ft. over the portion of bench to be removed. Cross-arms of 12-in. I-beams with hangers to hook under the wall plates were hung beneath the girders four at the front and twelve at the rear end. These cross-arms held up the wall plates while about 15 ft. of bench was taken out and the wall posts set up and then the girders were pulled ahead another 15 ft. The illustrations show all essential features of holding and bracing.

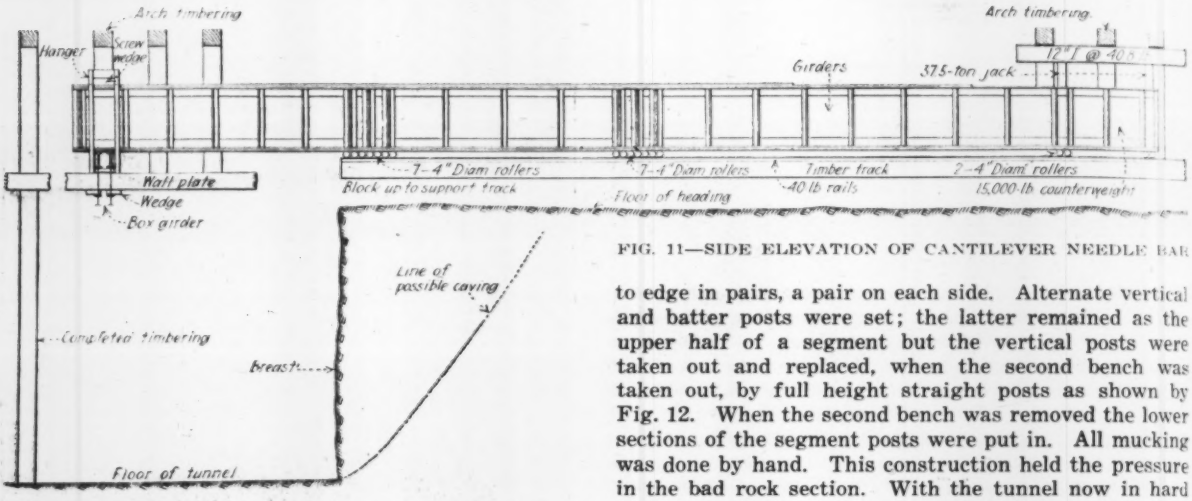


FIG. 11—SIDE ELEVATION OF CANTILEVER NEEDLE BAR

It will be noted that either plan for full-bench cut gave room for steam shovel mucking after the manner described for the east end. Neither, however, could be used successfully with the rock squeezing in the side posts. These were 20 ft. long. A stronger side timbering construction had to be developed, and a segmental side post construction, as shown by Fig. 12, proved successful.

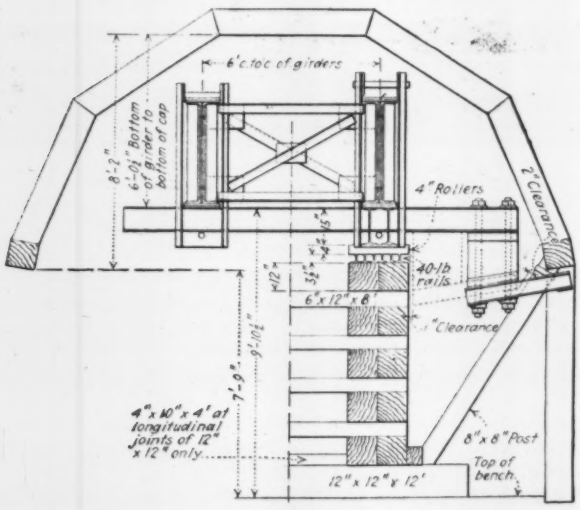


FIG. 10—END ELEVATION OF CANTILEVER NEEDLE BAR

The new form of side timbering is notable. It consisted of alternate two-segment arches and straight batter posts on 2-ft. centers. This arrangement gave finally a very strong structure against lateral pressures and a timbering which could be put in as the bench was lowered in two lifts. The method has been as follows: Using rakers to support the wall plate, one-half of the depth of bench was taken out. As the cut gave space half-length posts were set under the wall plates. These were footed on 6x12-in. sills laid flat edge to edge in pairs, a pair on each side. Alternate vertical and batter posts were set; the latter remained as the upper half of a segment but the vertical posts were taken out and replaced, when the second bench was taken out, by full height straight posts as shown by Fig. 12. When the second bench was removed the lower sections of the segment posts were put in. All mucking was done by hand. This construction held the pressure in the bad rock section. With the tunnel now in hard rock the methods of the east end are being adopted.

General Services—All equipment is operated by electricity or by compressed air from motor-operated compressors. As stated, current is brought in at 44,000 volts and stepped down to 2,300 volts for the larger units and to smaller voltages for hauling, blasting and other purposes. All underground cables and conduits are carried in the service tunnel except of course the extensions through cross-cuts up to the working faces.

In so long a tunnel, ventilation called for unusual care. For the main air supply at each end there are in the service tunnel two 4,000 cu.ft. per minute at 4 lb. blowers operated by 100-hp. motors. In addition two fans, delivering 12,000 cu.ft. at ½ oz., are located in the service tunnel just back of the last cross-cut to the completed tunnel. These are operated by 10-hp. motors.

MONTHLY PROGRESS IN DRIVING THE MOFFAT TUNNEL

	EAST HEADING in feet completed			WEST HEADING In feet completed		
	Water Tunnel	Main Tunnel	Enlargement	Water Tunnel	Main Tunnel	Enlargement
1923						
Sept.	.....	.....	.....	32	.....	
Oct.	76	.....	.....	295	.....	
Nov.	367	.....	.....	610	.....	
Dec.	638	26	.....	972	.....	
1924						
Jan.	1,014	303	.....	1,354	47	
Feb.	1,395	740	.....	1,729	215	
Mar.	1,937	1,285	30	2,187	510	
Apr.	2,294	2,027	333	2,554	775	22
May	2,999	2,737	533	2,976	1,047	166
June	3,676	3,404	787	3,383	1,603	376
July	4,135	3,960	1,087	3,930	2,466	481
Aug.	4,838	4,661	1,152	4,272	3,174	481
Sept.	5,432	5,262	1,660	4,633	3,766	481
Oct.	5,983	5,787	2,324	5,070	4,423	481
Nov.	6,580	6,384	3,173	5,554	4,730	558
Dec.	7,115	6,981	3,808	5,914	5,049	730
1925						
Jan.	7,785	7,653	4,360	6,167	5,605	958
Feb.	8,137	8,112	4,890	6,767	6,238	1,072

The blower line is 12-in. slip joint pipe. High-pressure air is carried in 7⅞-in. well casing.

The muck from the headings is taken out in 50-cu.ft. cars. These are hauled back by storage-battery locomotive to where the main trolley track has been carried into the service tunnel. Here the cars are picked up by a 250-v. trolley locomotive and hauled in 12-car trains to the portal where the small cars are dumped into 4-cu.yd. cars which go to the dumps. Trolley locomotives take the 4-cu.yd. cars used in enlarging section

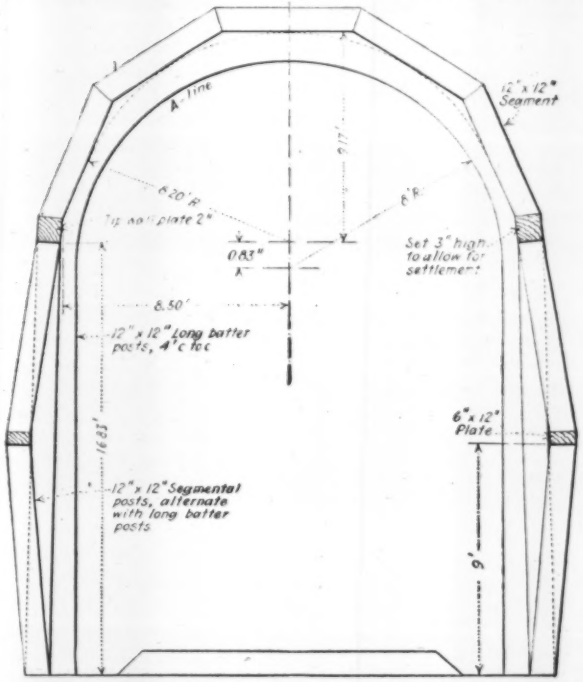


FIG. 12—TIMBERING FOR SQUEEZING POST AT WEST END
Timbering used with sub-bench method of excavation. Bench excavated in two lifts. Long posts not set until second lift is taken out. Temporary short posts used in excavation of top bench.

to the portal where, with the other 4-yd. cars, they are made up into trains for the dump.

Camp and shops call for no particular mention except to note that both were of the most modern character in comfort, sanitation and mechanical equipment. In particular, however, the large volume of timbering called for a high-class sawmill outfit.

On April 1, 1925, 49 per cent of the service tunnel was complete, 47 per cent of the main headings, 53 per cent of the cross-cuts and 21 per cent of the full-size railroad tunnel. In addition 2,287 ft. of top widening and 526 ft. of sub-bench was done in the enlarging operations at the west portal. Both sides are now in solid rock and the average monthly progress is 900 ft. total, which should bring the forces together within 16 months. The monthly progress to March 1, 1925, is shown by the table.

W. P. Robinson is president of the Moffat Tunnel Commission under the supervision of which the Moffat Tunnel is being constructed by Hitchcock & Tinkler, contractors, for whom F. E. Stokes and William Fowler are superintendents. George Lewis is general manager. R. H. Keays, chief engineer of the Moffat Tunnel Commission, is assisted by C. A. Betts, office engineer, and B. G. Coy and V. A. Kaufman, resident engineers.

Fifty-Mile Subway System for Tokyo Is Virtually Assured

Construction to Be Undertaken as a Municipal Venture—Benefited Properties to Be Assessed Part of Cost

Special Correspondence

A SUBWAY rapid transit system for the city of Tokyo, Japan, which will connect all the outlying districts with the central section, has recently been authorized by the action of the committee representing the various departments of the government. The proposition has been under discussion for nearly ten years, many plans have been prepared and a considerable amount of boring along proposed routes has been undertaken. As it now stands, the proposition is to be treated entirely as a city affair with the municipality taking charge of it, but as there are certain phases which call for national control the Department of Home Affairs, Department of Railways, Department of Finance, and the Reconstruction Bureau have all participated in the deliberations.

The cost of the proposed system is placed at $200,000,000, or approximately $4,000,000 for each mile. Financing has been one of the stumbling blocks during the discussion in past years, and it is realized that a foreign loan will be essential. The finance minister is understood to have approved of the plan which calls for a bond issue of $222,000,000 to be sold to bring a return

PROPOSED SUBWAYS FOR TOKYO

of 7.9 per cent. Every year from $12,000,000 to $22,000,000 worth of bonds will be issued to finance construction as it progresses. It is estimated that it will require from 12 to 15 years to complete the system.

The bond issue is to be repaid in three ways if the plan is finally adopted: First, through fares, second, through taxation, and, third, by special assessment upon benefited property. It is estimated that the entire bond issue can be repaid in twenty-five years with the present rate of increase in rapid transit passenger service in Tokyo.

A private subway company already has a 5-mile line in the northeastern section of the city under construction which it hopes to have in operation by next year.

Rehabilitated War Veterans Given Engineering Training

Disabled Veterans Educated in Engineering and Trained in Building Trades Are Now Available for Employment

By Brig.-Gen. Frank T. Hines
Director, U. S. Veterans' Bureau, Washington, D. C.

Readers of *Engineering News-Record* will be interested to know that the national government has educated for the engineering profession hundreds of men, and that the government still has in training for this profession many hundreds more.

These men are in training in the leading colleges and universities of the country and are scattered from coast to coast. The chief cities in which this training is given, and the number of men being trained for civil engineering in these cities, are as follows: Boston 14; New York 7; Philadelphia 15; Washington, D. C., 2; Cincinnati 12; Chicago 12; St. Louis 14; Minneapolis 24; San Francisco 7; Los Angeles 5; and Denver 13.

The government has also trained some 3,000 men for the various phases of building and construction work, and still has in training for this kind of work some 2,000 more.

This educating of men for the engineering profession and for the building trades on the part of the national government is a part of the work of training and educating the soldiers who served in the American Expeditionary Forces during the World War and who received wounds and disabilities that prevented them from working at the same occupations that they worked at before the war. This work is now entering upon its last phase and will terminate on June 30, 1926.

The scope of the work of our government in endeavoring to rehabilitate the disabled soldiers of the World War is realized by few. It has been going on since 1918. A total of 177,823 disabled soldiers has entered upon this training and education under the national government's jurisdiction. These men are from every section of the country and have been trained for almost every conceivable occupation. Some have been enrolled in practically every university, college, and school in the country, while thousands of others have been trained "on the job" in the factories and workshops of the country. More than 92,000 have finished their training, have been declared rehabilitated, and practically all of these have been placed in the kind of employment for which trained. Some 25,000 men still remain in training, and, as stated above, several hundreds of these are studying engineering and building. A large number of these will be declared rehabilitated and ready for employment in this month of June due to their graduation from schools and colleges.

The national government's work in connection with the rehabilitating of the disabled soldiers is carried on under the auspices of the United States Veterans' Bureau, a separate department of the government directly under the control of the President. Under the acts of Congress governing this rehabilitation work it is expected that the bureau will train these men for the vocations which they will be able to perform successfully. When the bureau completes the training of these so-called "disabled veterans" they are *in no sense disabled so far as their ability and usefulness is concerned in carrying on in the specific line of work for which they have been trained. The government aims to make them able men in their new vocations.*

The men that are being trained for the engineering profession and building are students in the best schools of the country. Much thought was given by the Bureau to the previous preparation, ability, and suitability of these men for the engineering profession and building before they were permitted to begin their course of study. The bureau is proud to report that many of its students of engineering have carried off honor grades in various schools.

It is the duty of the Veterans' Bureau, as provided for under the acts of Congress affecting this work, to secure employment for the men whom it has trained. This duty can be performed only through the co-operation of the general public. One of the brightest spots in the work of the United States Veterans' Bureau is the marked degree of co-operation that has been shown by the employing public in taking into employment the thousands of men whom the government has trained and rehabilitated.

It is especially difficult to find employment for persons that are being trained for the various professions. The bureau feels certain that it is appealing to a most receptive portion of the general public when it asks the readers of *Engineering News-Record* to render co-operation and assistance to the government in the employment of men whom it has trained and educated.

As the bureau has branch offices in practically all of the large cities of the United States, effective contact can be made by those interested with any one of these offices. The United States Veterans' Bureau, Central Office, Washington, D. C., solicits inquiries and correspondence from readers of *Engineering News-Record* who might favorably consider taking into their offices one or more of these deserving men as employees.

Results of Filter Plant Census

Of the 634 cities in the United States having filter plants of 1-m.g.d. capacity or over 587 are of the rapid sand and 47 of the slow sand type, according to census just completed by C. G. Gillespie, director, Bureau of Sanitary Engineering, California State Board of Health. In rapid filters Pennsylvania leads in number, but its 78 plants have a total capacity of only 307 m.g.d., against 743 m.g.d. for the 45 plants in Ohio. Although Michigan has only 18 plants the large one at Detroit brings the total capacity for the state up to 463 m.g.d. and into second rank in this respect. North Carolina has 42 plants but only 95.8 m.g.d. capacity. In slow sand filters, New York has 12 plants of 57 m.g.d. total capacity while Pennsylvania's 7 plants have 604 m.g.d. capacity. The District of Columbia comes next with 70 m.g.d. capacity. All told 23,664,000 people are served. Arizona, Nevada and Utah have no plants of sufficient size to be included in the count.

Dam and Power-House Reconstruction at Marinette, Wis.

Concrete Dam Replaces Old One of Timber Cribs—Small Trucks Deliver Concrete from Bridge Built above Dam—Hydro-electric Generators Supplement Direct-connected Water Wheels

By D. Graham Moon

Chief Engineer, Marinette and Menominee Paper Co., Marinette, Wis.

TWO WATER-POWER plants on the Menominee River on the boundary between Wisconsin and Michigan at Marinette, Wis., serve the Marinette and Menominee Paper Co. The upper or Marinette dam at Mill 1 is a gravity section concrete structure developing a head of 15 ft. and supplying the mill with 3,500 hp. in direct-drive waterwheels and 1,000 hp. in hydro-electric units. About ¾ mile below it is located the Menominee dam at Mill 2, an old dam originally built in 1882 for logging purposes and of rock-filled timber crib construction. The head on the dam was raised by means of flashboards when the mill was constructed in 1906, at which time concrete wheel pits were built at one end of the dam to house the waterwheels for the paper mill. The original dam was founded on hardpan which during the course of years had scoured out below the dam to a depth of 14 ft. below low tail water,

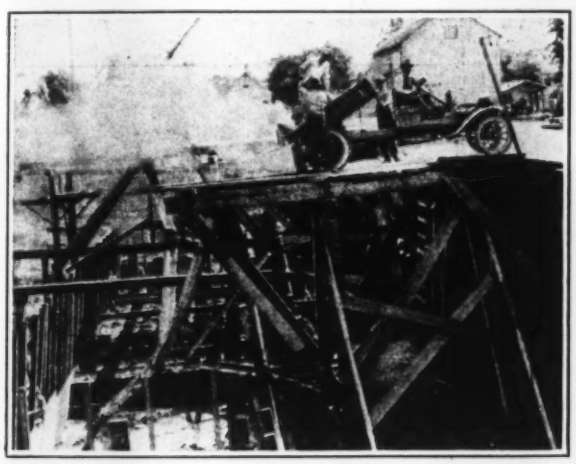


FIG. 1—DUMPING CONCRETE FROM TRUCKS TO CHUTE

exposing a fairly level stratum of limestone extending across the bed of the river. This scouring had continued back under the dam, and while it had not caused any serious leakage it was making the dam unstable. For this reason it was decided in the spring of 1924 to replace it with a modern structure and at the same time extend the power house to provide for two 600-hp. hydro-electric units to supplement the 2,500 hp. in direct-drive waterwheels. While the design of a suitable structure presented no unusual difficulties, the work was complicated by having to unwater the whole site to a depth of about 14 ft. and by the necessity for keeping the old power plant in operation, if possible, during the construction of the substructure of the new power house.

New Dam—The new concrete dam is of gravity type approximately 540 ft. long. On account of the wide variation in the flow of the river, 293 ft. of the crest is equipped with tainter gates and 150 ft. is a spillway section with provision for flashboards. At the Wisconsin shore the dam ends in an earth embankment with a concrete corewall. The details are shown in Fig. 2 and Fig. 3. A walkway from end to end of the dam provides access to the operating mechanism of the tainter gates and for the setting of flashboards on the overflow section. The whole structure is founded on rock and anchored with 2-in. pins set 3 ft. into the rock.

The tainter gates are operated by a traveling power hoist with an auxiliary hand-operated hoist for emergency. The hoists are of the worm-gear type with two drums taking the chains on the ends of the gates, the drive shaft connecting the gears for both drums being provided with a set of differential gears maintaining an equal tension on the chains, thus preventing twisting and jamming of the gates. Two of the gates are closed-in tight on their downstream faces to form a space in which steam may be led for thawing out the gates in case of winter operation. The steam lines are built into the handrailing.

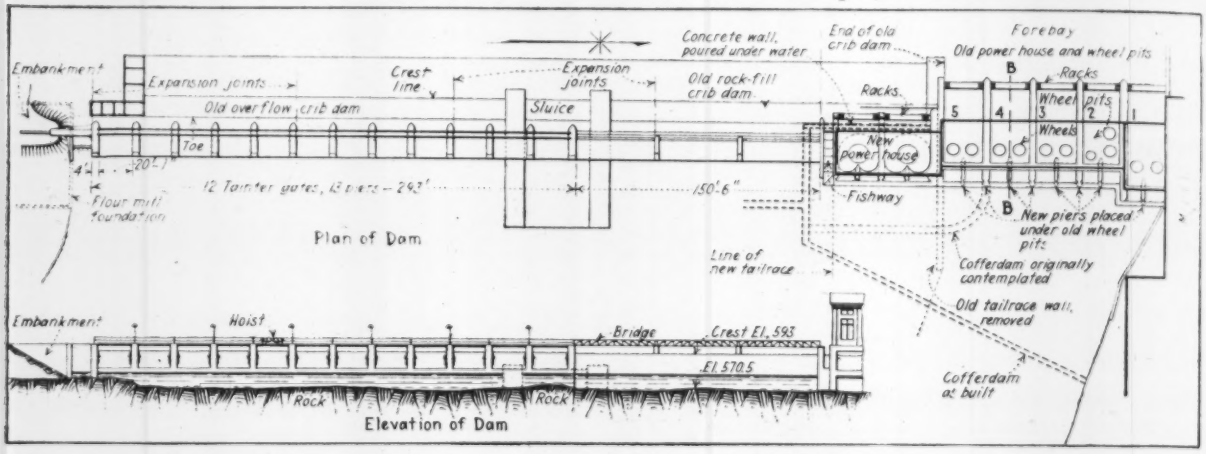
Construction Work—Owing to the undermined and leaky condition of the old dam, it was considered impossible to use it as an upstream cofferdam for the main dam, while at the north end there was no possibility of building any sort of temporary dam as the substructure of the power house had to be built practically into the face of the old dam. For this reason, the upstream wall of the power-house foundations was begun by sheeting against the toe of the old dam, sinking forms and pouring a wall 4 ft. thick along the entire length of the new power house, using a tremie to place the concrete. This wall formed the anchor for the north end of the upstream cofferdam for the main dam. Later, when it was unwatered, it was found to be in good condition.

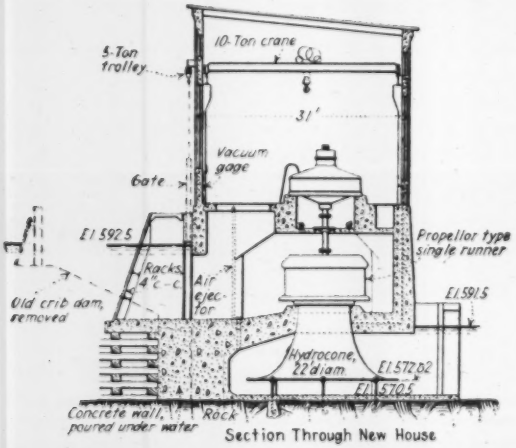
A space of 14 ft. between the toe of the old dam and the new dam was the only place available for an upstream cofferdam due to the fact that if the dam had been located further downstream the downstream cofferdam would have had to be located on loose rock and slabs of limestone where it would have been hard to make it watertight. A cofferdam was constructed in this space of timber cribs filled with clay, a width of 18 in. being left below the old dam for sheeting the crib with the aid of a diver. For fear of this cofferdam pushing in, cribs were built against its lower side, spaced about 40 ft. apart, and rock filled, the new dam being built in sections between these cribs, and then the cofferdam braced against the new structure before removing the rock-filled cribs.

Power-House Foundations—Examination of the foundations of the existing power house by diver showed that there were parts badly undermined on account of their not being carried to rock when first built. It was decided, therefore, to allow the contractor to construct his cofferdam for this part of the work in such a manner as to take in all the existing wheel pits which originally it had been intended to keep running. This

meant shutting down the mill for the time of work inside the power-house cofferdam. However, by working night and day the time required to build the cofferdam, pour the concrete for the new power-house foundations, set the steel hydraucones and build 12 additional concrete piers under the existing power house was reduced to two weeks. The arrangement of the cofferdam and the layout of the new buttress piers under the old power house are shown in Fig. 2. The breast or front wall of the wheel pits of the old power house was supported in the middle of each wheel pit

ities made it possible to deliver sand and gravel from cars to a storage pile and bin over the mixer. The mixer was approximately 350 ft. from the near end of the dam and to transport and place concrete and other materials a trestle was built out across the stream partly on the old dam and partly on the upstream cofferdam. Concrete was transported in one-ton Ford trucks equipped with dumping bodies, which handled a little over $\frac{3}{4}$ yd. at a trip. Using three trucks, as much as 400 yd. of concrete were placed in 10 hr. The trucks also handled such material as lumber and reinforcing





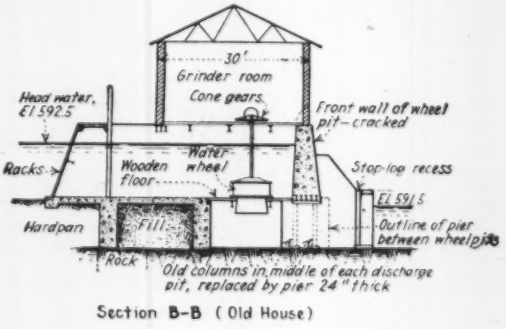


FIG. 2—PLAN AND ELEVATION OF DAM AND DETAILS OF POWER HOUSES

by two cast-iron columns. This wall had no reinforcing and was cracked in several places. To avoid the possibility of its overturning, new piers were built under it to replace the columns and extended out to form buttresses. These piers were equipped with stop-log recesses and spanned by a concrete walk to make it possible to close off and unwater any or all of the wheel pits for future reconstruction work. The necessity for shutting down the old power house was taken advantage of by inclosing a large area of the tailrace within the cofferdam so that it could be cleared of loose rock and hardpan in the region in front of the new power house. There was considerable leakage into this cofferdam through the upstream walls of the wheel pits of the old power house which was shut off by grouting the cracks under pressure.

Concreting Equipment—The concrete mixing plant was located on the Wisconsin side where track facil-

material. The trestle was also used for transporting machinery to the new power house.

The quantities of material involved in the work were 7,000 cu.yd. of concrete, about 5,000 cu.yd. of excavation and embankment, 130 tons of steel, 70 tons of reinforcing, and 1,500 ft. of cofferdam.

Removing Old Timber Dam—Upon completion of the new dam the old crib dam was removed down to the level of the tainter gates, and back of the power house down to the depth of the bottom of the racks. This operation had to be carried out in such a way that use of the water power for the mill would not be interfered with. To remove the old dam, holes were bored into the timbers of the crib work, each hole being loaded with one stick of dynamite; larger charges were placed under the toe. Then, with the full head on the old dam, these charges were fired instantaneously, the resulting rush of water tearing out and removing much of the

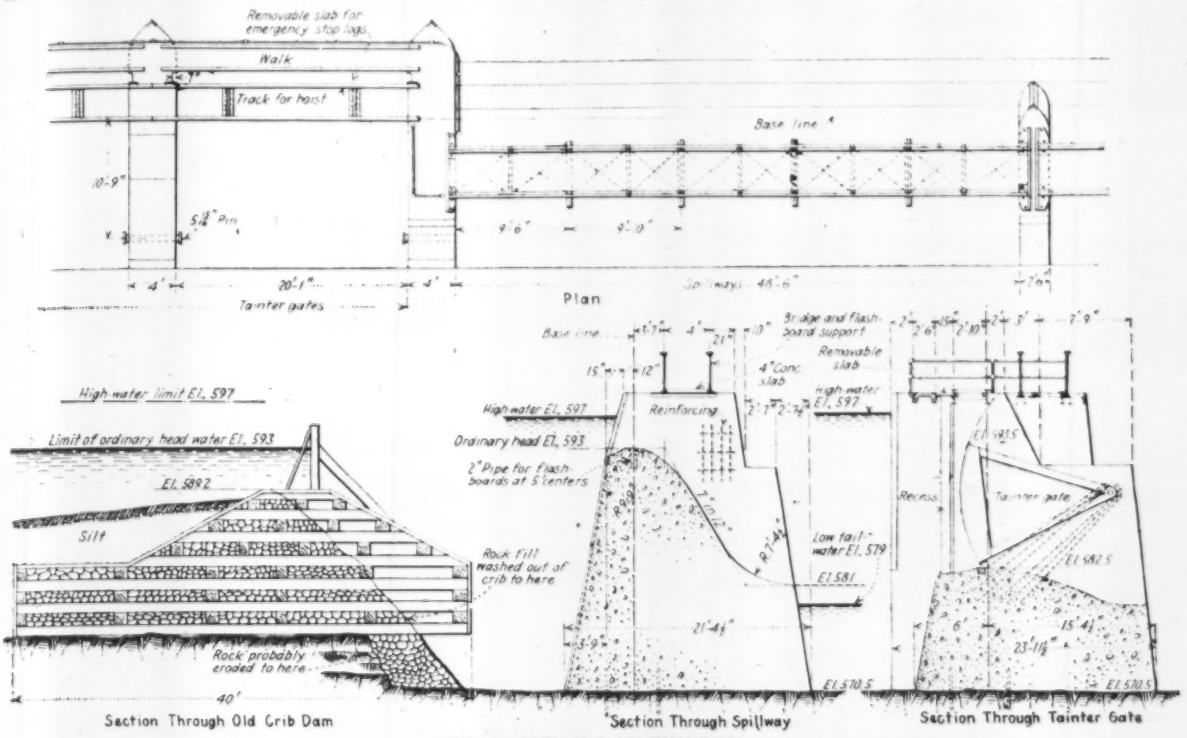


FIG. 3—DETAILS OF THE DAM

timber work. During the following day the water at the upper dam was held for a period of four hours, allowing the draining of the lower pond, and during this period enough dynamite was used to remove the balance of the old dam successfully, the débris being sluiced out through the new gate sections.

Power-House Equipment — The type of turbine adopted for the new power house was four-bladed propeller type vertical runner in an inclosed flume with a vacuum setting and using White hydrocone regainers. The units are guaranteed to give 560 hp. at 11-ft. head and 138½ r.p.m. The electrical generators are direct-connected 500-kva., 480-volt, three-phase, 60-cycle vertical units, the generator rotors and runners being carried by thrust bearings.

Preliminary tests upon the new units show that they produce some 15 to 20 per cent more power than was guaranteed, and that the efficiencies have exceeded the requirements, that at partial gate openings they are much better than originally estimated, the usual characteristic of this type of runner being that the efficiency drops off very rapidly when below 0.8 gate opening. In this case it did not drop below 80 per cent until it reached 0.55 gate opening; the best efficiency being at about 0.85, when it was 87 per cent.

The new units are to be operated in parallel with the other hydro-electric units at the upper plant, the two mills being connected by a 4,000-volt transmission line and the whole system operated in parallel with power delivered and purchased from the local power company. The new units are equipped with automatic control devices. Both the hydraulic and electric machinery were furnished by the Allis-Chalmers Manufacturing Co.

The wheel pits are designed to give a low entrance velocity and are arranged in such a way that when the air is removed by the ejector the water rises on the inside some 3 or 4 ft. higher than the headwater, completely submerging the wheels and preventing admission of air to them.

To provide access to each wheel pit an airtight hatchway is built into the power-house floor. This hatchway

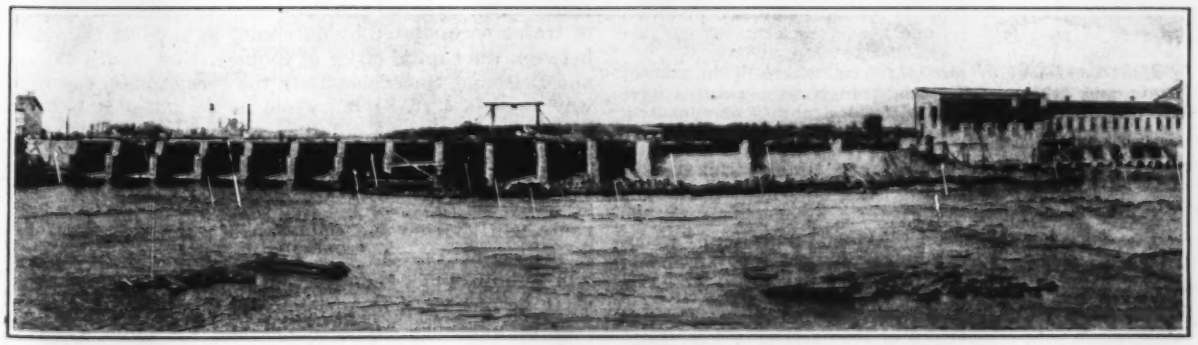


FIG. 4—UPSTREAM VIEW OF NEW DAM; OLD AND NEW POWER HOUSE AT RIGHT

is 92 in. long, 26 in. wide, the turbines being so designed that the largest portion will pass through this hatchway. The wheel pits are of reinforced concrete throughout and are provided with two steel gates for closing off the water, each built in one piece, operated from a trolley and beam running along the outside of the power-house wall. The racks in front of the flumes are 3x⅜-in. bars spaced on 4-in. centers, and constructed in such a manner that they can be removed in sections for repairs. This wide spacing of rack bars with its many advantages was made possible by the ability of the propellor-type runner to pass large objects without damage.

Engineering and Construction Staff—The contract for the dam and power house was let to C. R. Meyers & Sons of Oshkosh, Wis. Work was commenced on June 15, 1924, and completed by November. The contractor's representatives on the ground were P. Lewis, M. V. Fritz, F. Ganzer and H. Ganzer. The dam was designed and the installation carried out by the engineering force of the Marinette and Menominee Paper Co. under the direction of the author, with C. R. Boast and E. R. Reider as resident engineers.

Current Research in Materials

ANALYSIS of research work in the properties of materials now going on within the American Society for Testing Materials recently carried out by C. L. Warwick, secretary, shows that a remarkable amount of such investigation is going on, covering much of the field of the principal materials of construction. An abstract of the list, with occasional notes on the status of the work, is given below for general information.

STEEL AND WROUGHT IRON

Effect of sulphur and phosphorus on the mechanical properties of steel—In charge of a joint committee representing a number of organizations. Work up to the present has been confined to the effect of sulphur, and has shown no measurable effect of sulphur in percentages up to 0.10 to 0.15 per cent.

Properties of reinforcing bars made from different grades of steel.

Properties of forgings as affected by rate of reduction between ingot and bloom—Will cover rates of reduction from 2:1 to 4:1.

Corrosion of bare and metallically coated steel sheets under atmospheric exposure and total immersion—Tests of bare sheets partly completed; tests of metallic coatings recently begun.

Accelerated corrosion tests, with special application to metallic coatings on steel.

Magnetic properties of steel as related to mechanical properties—Tests on twist drills have been completed, with inconclusive results.

Quality of wrought iron as influenced by raw material, process of manufacture, and heat treatment—Work just beginning.

Heat treatment of wrought iron, especially in case of chain and other articles where high temperatures have been applied—To cover also the desirability of annealing iron chains from time to time. In early stages.

CAST IRON

Arbitration test bar for international use.

NON-FERROUS METALS

Test bars for cast non-ferrous alloys.

Babbitt metal—To determine physical properties, correct pouring temperatures, effect of impurities, and best shape of test piece.

Corrosion resistance of non-ferrous alloys—Current work deals with comparison of four accelerated corrosion tests.

CEMENTS AND CLAY PRODUCTS

Compressive strength tests of cement mortars—Delayed for a number of years and awaiting resumption.

Short-time strength tests for cement—Study of a possible three-day or four-day mortar strength test for portland cement; in preliminary stage.

Older and newer types of hydraulic cements—In preliminary stage.

Compressive strength tests of brick—In preliminary stage.

Condition of bricks in old buildings—Status indefinite.

Disintegration resistance of drain tile under exposure to alkalies and acids in the soil—A co-operative investigation by four separate agencies; in active progress.

Plasticity of lime—Includes study of relation between plasticity and sand-carrying capacity; status indefinite.

Effect of lime in various uses—A series of studies that have been in progress for some time, covering panel tests of plasters, agricultural and road uses.

Concrete proportioning—Data in hand and analysis to be made.

PAINTS

Paint materials and varnish—Includes the study of properties as well as test methods, for paint oils, thinners, shellac and varnish.

Surface preparation of iron and steel for painting—Extensive exposure tests in progress for eight years.

Ship paints—Anti-corrosive and anti-fouling properties under investigation by panel exposure tests and actual tests on ship bottoms; in progress for some years past.

Physics of paints and paint materials.

RUBBER

Performance tests for rubber products—Work begun two years ago, covering a number of special tests for service properties.

SCREEN WIRE CLOTH

Relative life of various screen cloths under atmospheric exposure—In active progress.

GENERAL SUBJECTS

Brittleness and impact tests of metals.

Plasticity, consistency and related properties of materials.

Thermal analysis of metals.

Micro-hardness.

Most of the work above listed does not have direct relation to the preparation of specifications or formulation of test methods in the course of the work of the standing committees of the society. However, in the latter field there is also much work in progress.

A large part of this research work was initiated during the past few years, and further extension is in progress. Many laboratories are co-operating in the researches and it is expected that ultimately all investigative agencies concerned with materials will join in the work.

Australian Line to Avoid Change of Gage

An important piece of railroad work in Australia is being undertaken to eliminate the objectionable change of trains necessitated by difference in gage on the route between the capital cities of Sydney, New South Wales, and Brisbane, Queensland. In the former state the railway gage is 4 ft. 8½ in., while in the latter it is 3 ft. 6 in. An existing 85-mile line from Grafton to Kyogle, New South Wales, will be reconditioned to form part of a new main line and then extended 97 miles to Brisbane, crossing the range at the Random Gap pass. This new route will shorten the time between the two cities by about six hours. As this will be an interstate line it will be built under the direction of a special commission of three members, comprising the Commonwealth railway commissioner (chairman) and the chief railway commissioners of New South Wales and Queensland.

Engineering in the Small City

A series of notes from the field on the Problems and Practices of the Municipal Engineer in the Cities Below 100,000

The Editor Visits the City Engineer

Snapshots of Our Representative Small Cities

Lynchburg, Va.

A CITY IN VIRGINIA, 147 miles by rail west by south of Richmond, on the James River. Much of city picturesquely built on terraced hills above James River, with the Blue Ridge Mountains in background. Site of Randolph Macon Woman's College and other schools, and three hospitals. Manufactories comprise tobacco, hardware, plow and wagon factories, flour, cotton and textile mills, pipe and dye-works, brickyards, iron and brass foundries. Surrounding territory contains extensive resources of coal, iron and granite. Founded 1786 by John Lynch, incorporated 1823. Was in territory of major Virginia operations in Civil War. Pop. (est. 1924) 35,000.

FOR many years prior to 1920 the municipal affairs of Lynchburg, Va., were administered by a bicameral government. Expenditures were made as a matter of course upon improvements obviously necessary, though there was little system in the purchase by the city of supplies or equipment. The highest prices were usually paid in an open market. Council committees found it usually advisable to spend all of the money appropriated for the various services, mostly because an unexpended balance would have further complicated an already tedious and involved system of accounts. The electorate of the city found this form of government finally too unwieldy and in 1920 the council-manager form of government was voted in, chief legislative authority being vested in a council, and complete administrative authority in a city manager. Major Edward A. Beck was appointed city manager, and largely through his efforts Lynchburg has become a well-ordered business establishment with a definite program of municipal improvements that has added scarcely a cent to the bonded indebtedness of the city. A study of this city, therefore, is practically an inquiry into the city-manager form of government under Major Beck and a review of the accomplishments of the past four years.

Organization—The city's official family is divided into the council, of which the mayor is one of the five members, and the financial, legal and judicial and administrative departments. Under Major Beck, who is the administrative head and who, incidentally, is one of the pioneers among city managers, are the purchasing agent, director of public works, building inspector, director of public service, superintendent of water department, director of public welfare, superintendent of hospital, superintendent of city home, superintendent of city farm, superintendent of market, chief of police, chief of the fire department, city electrician, superintendent of recreation and playgrounds, superintendent of parks and superintendent of the cemetery. With the director of public works, R. W. B. Hart, a member of the American Society of Civil Engineers, as is also Major Beck, in charge of the design and construction of streets, sidewalks, sewers and other public improvements, all technical services have either direct or general competent technical supervision. The business of administration is further simplified by a liaison between the director of public works and the director of public service, J. E. McCarron, quite lacking in any political jealousy or hostility. Street maintenance and cleaning, refuse disposal, sewer maintenance and superintendence over shops and stores are all functions of the director of public service.

When Major Beck first took hold of the administrative reins at Lynchburg there was no centralization of buying power. With the organization such as it is now the city is able to buy all of its supplies much cheaper than before. Economies have been effected in elimination of duplicate services. Simplicity and efficiency have been injected into the flexible accounting system. This centralization of buying power on the part of the city has been largely responsible for another noteworthy condition—the city does all of its own construction work. Both the accounting and construction under city forces merit special discussion.

During the past five years the city has embarked upon a broad program of municipal improvement. The assessed valuation of all property within the city limits is approximately $55,000,000, and the bonded indebtedness little more than $3,500,000. Though previous to 1920 municipal improvements had been slow, since that time more than $1,000,000 worth of work has been done, most of it is paving construction and reconstruction, and all of the money has been taken from current revenue. For instance, there are 86 miles of paving and 2¼ miles of park streets in Lynchburg. Of this 49¼ are paved and 18 miles of the 49¼ have been paved since 1920. Sidewalk work has kept pace with this program. The impetus given new work is remarkable, particularly when it is known that the city cannot make mandatory the improvement of a single street, assessing the abutting property therefor.

With money coming almost entirely from current revenue, and with no increase in the general city tax rate over that existing during the days prior to 1920, new improvements are given an appropriation based on the engineer's estimate. Each city department has a code designation. For instance the designation for the department of public works is *D*. *TD* represents capital outlay of the department, *TDB* capital outlay on paving, *TDF* capital outlay on sewers, and *TDA* sidewalks. *TDBA* will therefore represent the first paving job which the city undertook after the code system was adopted. Each job therefore bears its own code number which is attached to all bills for material, labor or other expense. Each month the auditor foots up the expense on that and all other jobs and subtracts the total from the appropriation. With each city department sending through numerous items, the facility of following the code system is seen when one considers that one man, the city accountant, keeps all balances on all

items himself. The code also facilitates reference, and gives immediate information as to the number of jobs carried through so far since the system was established. For instance the newest sidewalk job has been given the designation *TDAB*—7, which indicates that the alphabet has been run through eight times.

Development of Municipal Construction—The city was practically forced into doing its own construction work. In 1921 when it embarked upon extensive sidewalk and paving work the department of public works put in a bid in competition with a number of contractors. When the bids were opened it was found the city bid was far below any competing one; so it did the work, below the estimate at that, and has gradually added to its equipment and forces until now all of its construction is by city forces. It has an organization of about 150 men at work most of the time and does more than $250,000 worth of work each year. It has acquired equipment until its shops house almost a score of automobiles and trucks and all repair work for all city equipment is done under one roof. In 1923 the city bought and installed its own asphalt plant.

It is practically impossible to draw a comparison between the cost of doing work on this basis and by contract. The city owns land upon which are built both the shops and storehouses which would otherwise be idle. There is very little increase in the overhead but what there is is charged to the job. Engineering expense and profit can be largely discounted. The city's established credit is a decided asset when it is doing its own work. And it can take advantage of cash discounts in material and supplies purchases of which the average contractor is financially unable to avail himself. It is readily asserted that Lynchburg would perhaps not have gone into day labor work had it been possible four years ago to get satisfactory bids. But now the custom is well established. On large jobs where special equipment and plant are required, contracts will be let. The first of these will be the reconstruction of the Rivermont Viaduct, plans for which are being made. The job involves the encasement with concrete of a 900-ft. steel structure 150 ft. high. Consulting engineering advice has been sought on this job, which, it is estimated, will cost in the neighborhood of $300,000.

Street Work—Lynchburg's original paving was mostly of rubble or cobblestones and brick, with the former prevailing. This was probably due to the fact that the streets are so steep (the city is spread over seven hills rising abruptly from the James River) and to the availability of stone either with a short haul or locally. The rugged topography, incidentally, makes sewage disposal an easy matter, the combined system discharging through a number of outlets into the James River.

Since new paving and reconstruction have formed the major construction work in the past four years care has been exercised in the adaptation of types to the topography and the kind of traffic. As a general rule the following types govern: slag-macadam for secondary streets even on rather steep slopes, where the traffic is not extensive, though it may be heavy; concrete in residential streets where little trucking is done; asphaltic concrete on a rubble base for main thoroughfares and brick on concrete base or on rubble on heavy pavements. Exceptions to all these adaptations are to be expected, but the general desire is to fit the pavement to the topography and traffic.

Engineering Work

The city has had good results from its slag-macadam streets. Before laying such surfacing the street is brought to grade or if graded shaped and about 8 in. of blast-furnace slag put on. Into this is worked about ten to fifteen per cent by volume of stone dust and screenings and the whole rolled until compacted. It is then sprinkled and rerolled. When traffic has consolidated it a cold tar is spread on as a binder, the usual application being ½ gal. per sq.yd., and covered with chips. Hot tar is then applied at the rate of ⅓ to ½ gal. per sq.yd., chips or pea gravel applied and the road is again rolled. From such streets, which cost about 60 cents a square yard exclusive of heavy grading, the city expects to get a life of ten years under ordinary wear and with ordinary maintenance. Rubble gutters are laid where grades are very heavy.

Concrete is plain though reinforced over trenches and unstable subgrades, and with a thickness at the center of 8 in. with edges 6 in. for a 24-ft. roadway, and 7 and 5 in. on roadway widths of 18 ft. or less. For this type of paving, and it has been used on other types as well, a monolithic concrete curb and gutter section has been developed. It is much less expensive than the granite curb and brick gutter and with the face of the curb curved and the outside edge of the gutter thickened great resistance to breaking down by heavy traffic is offered. Laying plain concrete with no topping is considered the economical procedure. Should heavier and greater traffic come on the pavement later and wear it down the concrete will serve as an adequate base for a durable wearing surface.

The asphaltic topping which the city is using is a modified topeka. The usual thickness is 2 in., though 2½- to 3-in. thicknesses are at times laid. That type prevails where old rubble streets are resurfaced. However, where the grades are too steep, that is above 8 or 10 per cent, hillside brick is employed. Old material is always salvaged and rubble used either for gutter work on secondary streets or for patching rubble streets that have not yet reached the reconstruction stage. On several jobs an old stone crusher was rehabilitated and the worn stone block were crushed for aggregate for concrete streets. Every means is used to get the maximum life out of the material. Brick streets have been torn up and the brick cleaned, turned and relaid, assuring a number of years still of usefulness with a minimum of expense. Brick are laid on a sand-cement cushion with an asphalt filler. The filler is applied at the rate of 1⅓ gal. per sq.yd. and the surface, before rolling, spread with stone chips. The resulting mat is found not only to offer great protection to the wearing surface of the brick but to bind them together with greater certainty, an especial function being elasticity.

Water Supply—Water for Lynchburg comes from the Blue Ridge Mountains. It is piped about 21 miles from Pedlar River, the impounding reservoir having a capacity of about 400 m.g., in a wood-stave supply line with a capacity of 9 m.g.d. Much of the watershed was recently sold by the city to the federal government at a neat profit. It is now part of a Forest Reserve, and therefore a safe source. Water is led by gravity to the filtration plant, with twelve units, and the filtered

Of the Small City

water is stored in two reservoirs having a capacity of 7½ m.g. An emergency supply is available from the James River, though the pumping plant at the river has been recently used only once and for a short time when there was a blowout in the supply line.

Though the city now has an area of less than 5 square miles it is probable that that area will be increased to 14 with the incorporation of fringe communities. State authority has been granted for such procedure, though the state has made it incumbent upon the city to pay for certain public improvements made by the counties and property owners in these communities. This will mean a great deal of valuation work before the new property is acquired and a great amount of expense.

Home-Made Concrete Pipe Replaces Town Drainage Ditches

NINE miles of municipal drainage ditches were replaced with covered drains of concrete pipe last year in the town of Emporia, Va. These ditches, provided in 1916 as a means of eliminating the mosquito and malaria nuisance, were located on property lines as far as practicable and received all street drainage and waste water except sewage. In a few years the sides had caved until the ditches were double their original size and being in both the business and residence sections they were unsightly and decreased the value of the property; the maintenance cost was increased by the caving and there was considerable objection to the mud thrown out in cleaning. Although the advantage of these ditches in regard to mosquito control and public health was recognized it was considered desirable to replace them with covered drains and after various methods had been suggested it was decided to make and lay concrete pipe.

Two forms for 30-in. and 24-in. bell-and-socket pipe in 30-in. lengths were purchased by the town council, and the pipes were made by the regular street force. Two men were allowed two hours for taking down, cleaning, greasing and setting up the two forms and mixing and placing the concrete. The cost was 87½ and 68c. per foot for 30-in. and 24-in. pipe, but when two more forms were purchased the two men could make four pipes in three hours and the cost was 73 and 56½c. per foot. The mix is 1:1¾:2¾, using gravel of ½-in. maximum size and placing six rings of No. 9 wire in each pipe.

After being used 160 times the forms showed but slight depreciation and required no repair. The pipe is left in the form for two days and is then rolled to the adjacent storage yard and allowed to cure for three weeks. It can be made at odd times or as funds are available. In laying, manholes are provided about 100 ft. apart for cleaning and flushing. The cost on two stretches of 30-in. pipe has averaged $1.33 and $1.37 per foot for making, laying and covering, including also the manholes.

This economical method of eliminating the open ditches was recommended by George S. Bote, scientific assistant, U. S. Public Health Service, and is described by him in an article in the U. S. Public Health Reports of March, 1925.

Resurfacing Worn-Out Pavements

THE city of New Brunswick, N. J., is carrying on a paving program which, during the last three years, has called for an annual expenditure of around $200,000. While some of this is new construction a great amount of it is resurfacing. In all the resurfacing work sheet asphalt is being used. The principal types of old pavement upon which sheet asphalt is being laid are Belgian block, concrete and macadam.

To resurface the Belgian block the block are thoroughly broomed first. Any bad depressions are then filled with a binder of tar and stone. In some cases block are reset, but resetting depends entirely upon the condition in which the block are found. A 1-in. layer of binder is then placed on the block and rolled thoroughly until compacted. The wearing surface, 1½ in. of sheet asphalt, is then put on and rolled first with a 6-ton tandem roller and then with a 10-ton roller.

To resurface the macadam it is first scarified and then shaped and rolled. Most of the macadam being resurfaced is 8 in. thick, some of which is laid on a telford base. No binder is put in on the macadam, but a sheet asphalt top 2 in. thick is placed and rolled.

On concrete, which is usually 5 in. thick, no binder is used, but a 2-in. surface is laid.

At the present time the city is resurfacing a patented concrete pavement about 18 years old. The concrete was originally laid to a depth of about 5 in. and upon that was laid a pitch coat impregnated with stone screenings. This pavement has worn badly, though the concrete has stood up well. It is being resurfaced by cleaning, filling holes with the binder and then putting on a 1-in. binder course, topped by the sheet asphalt.

As the grade of these streets has been raised it has been necessary to raise the level of manholes and water gate boxes. Paving material is simply cut away from around the manhole or gate box and the former extended with a brick course, the latter with longer pipe.

During the present season resurfacing has cost $1.96 per square yard for binder and sheet asphalt top.

How Knoxville Picked Consulting Water-Works Engineers

After it became known that Knoxville, Tenn., would make extensive water-works improvements in view of a report on the local water situation made last September by Col. Frederick W. Albert, engineer of water-works, the water department had requests from 40 to 50 consulting engineers, asking that they be considered as candidates for designing and superintending the construction of the improvements. General consideration of all the candidates having been given by Louis Brownlow, city manager, Colonel Albert, and Service Director Alexander Harris, five engineers or firms, located in three cities, were asked to visit Knoxville, interview the local officials and go over the works. These were: From Chicago, Alvord, Burdick & Howson, and Maury & Gordon; from Pittsburgh, the J. N. Chester Engineers; from New York City, Fuller & McClintock and Nicholas S. Hill, Jr. A proposal was also received from Charles B. Hawley & Co., Inc., Washington, D. C. Before a final decision on the appointment was made by Mr. Brownlow inspection trips to works built by the various engineers were made by Colonel Albert and Mr. Harris. Recently City Manager Brownlow announced selection of Alvord, Burdick & Howson.

Harmony at Orlando Convention of A. A. E.

Dissension Ended—Tide Turned in Membership—Work of Committees—D. B. Steinman Becomes President

WITH representatives from coast to coast and with an especially large delegation from the western districts, the American Association of Engineers assembled at its eleventh annual convention at Orlando, Florida, June 2 to 5. Forty-eight delegates, representing about fifty-five chapters, and nearly one hundred additional members were present.

Considerable time was devoted to the consideration of committee reports. Notable progress in the work of many of the national committees was evidenced by the constructive character of these reports.

An initial difference of opinion between a small group of chapters and the Board of Directors was smoothly ironed out upon full discussion of the matter, in an open session of the Board of Directors, which resulted in the correction of previous misapprehensions. At first there seemed to be a division of feeling as to the relative function and authority of the central organization and its local sub-divisions, but when the convention brought together the respective advocates of the divergent viewpoints it ultimately brought about a condition of complete understanding.

Professional Committee Reports

Political Policies—Every engineer was urged to take an active interest in politics and to perform his duties as a citizen. He should study political issues and express his views when opportunities arise. The most important features of this report were two sections urging the co-operation of committees of engineers with the state organizations to "place on the statute books laws safeguarding and protecting the engineer and the profession," and endorsing the work of the national Washington office.

Employment—The employment committee reported 1,647 placements for the year 1924. Association Employment, Inc., placed 451 men during 1924. Chapter placements were 300 for Portland, Ore., 251 for San Francisco, 225 for New York, 163 for Kansas City.

Insurance—During the year, the association entered into a contract with an insurance company to furnish insurance—life, health and accident—to members at rates substantially lower than can be secured elsewhere.

Student Membership Committee—The committee on student membership made definite recommendations concerning the three problems of (1) fostering the student membership movement, (2) convincing student members of the value and importance of the work of the association and (3) following up student members after graduation.

Recognition of Individual Merit—The report of this committee recommends "that when noteworthy service is rendered by an engineer, either for the benefit of the association or for the benefit of humanity, steps should be taken, in conformity with our code of ethics, to secure recognition of such service."

Ideals and Objects—This committee recommended development of the employment service; further improvement of the *Professional Engineer;* encouragement of chapter activities on local public questions; revision of the organization that will make possible a reduction of dues, with the chapters financing their own local activities; establishment of a field secretary service; and organization of a conference committee to bring about "the formation of an all-inclusive general engineering organization."

Engineers in Public Service—The committee reported that a start has been made in the gathering of data concerning the salaries paid in city, county, and federal positions of an engineering character.

Practice—The outstanding report of the convention was that of the Practice Committee, under the leadership of the newly elected president, Dr. D. B. Steinman. The principal features of the work of the committee have been the expansion of its scope, and the stimulation of the consideration of outstanding practice problems by engineers. To secure the consensus of opinion on some of the major unsettled practice problems, a questionnaire was sent out to a list of representative engineers. A condensed statement of the results of this survey was given in the May 21 issue of *Engineering News-Record*, pp. 851-854.

Practicing Engineers—This report furnished a constructive contribution to the important subject of the fees of practicing engineers. Curves were given to indicate the recommended minimum fees for engineering services. The fees were placed on a graduated percentage basis and may be converted into lump-sum fees or into monthly-payment fees to suit particular circumstances. These fees cover the items of preliminary investigation and report, detailed plans and specifications, complete supervision over construction, and advisory supervision over construction. The report recommended the publication of a handbook which should contain (1) rules of the Practice Committee, (2) rulings of the Practice Committee on specific cases, (3) code of ethics, (4) a readable article on how to employ and use engineering services, (5) typical form of contract, and (6) schedule of fees.

President's Address—In his formal address, the retiring president, Morris Bien, of Washington, D. C., said, in part:

> In the effort to serve the public the mind naturally turns to the problems of the day, and accordingly the difficulties of agriculture, our basic industry, claim attention. The study of conditions and working out a remedy can be performed most efficiently by the engineer.
>
> The engineer's professional standing deserves attention in order to bring home to the public the fact that there is a distinction of vital importance between the professional engineer and those who assume the title of engineer without the warrant of knowledge and experience, such as where plumbers call themselves sanitary engineers. This misuse of the title is fostered by the false and misleading advertisements in many magazines supposedly responsible to the effect that students can be trained in engineering by correspondence in a few months so that they may command salaries ranging as high as $12,000 per year.
>
> Unity in the engineering profession is necessary to weld the 200,000 men in the divers branches into one body that shall endeavor to secure co-operation toward establishing the principles that are best for the advancement of the public interest, as well as the interest of the profession.

He asserted that the remedy for misuse of the title "engineer" is a countrywide policy of the registration of professional engineers. The chapters were urged to make themselves important factors in their localities, thus serving the public interest, and at the same time benefiting the members by reason of the knowledge and

experience of public affairs necessarily attained in connection with this activity.

Business

Membership—The report of the Directing Manager indicated a decline in membership over a period of four years until the low point of 7,000 fully paid-up adult members was reached on Dec. 31, 1924. On May 20, 1925, the report showed an official total of 8,263. More recent records indicate a gradual increase of membership, to some extent made up of new applications, but to a greater extent of reinstatements.

Finances—The reduction in membership, the cost of publication of a directory of members, and the deficit of Association Employment, Inc., all contributed to a net operating loss for the fiscal year ending March 31.

Washington Office—The report of Allen B. McDaniel, the secretary of the national Washington office, indicated material progress during the past year in legislative work, service to members, service to the profession in governmental matters, representation of the association before various federal agencies, and at conventions, congresses and conferences. One of the features of the work of the office has been the co-ordination of the activities of a large number of chapters in the study of such national issues as fuel economics and motor-traffic control.

Amendments to the Constitution and By-Laws—Following the excellent precedent set by the San Francisco convention, the Orlando convention refused to tinker with the administrative machinery. After long study of a report for the modification of the constitution and by-laws, principally covering the simplification of membership grades and entrance qualifications, and the reduction of dues, the resolutions committee's recommendation to disapprove carried.

A resolution to nominate and elect national officers on the floor of the convention and with a provision for automatic succession in office, was defeated by a vote of 3,092 to 2,247.

A resolution to establish a nation-wide employment service with an office and manager in each district, was recommended to the Board of Directors for favorable consideration.

A new emblem was adopted, a simple dignified design, rectangular in shape and containing the name of the association in gold letters on a blue background.

The termination of the convention was marked by a number of effective talks by representative delegates expressing the spirit of harmony and fraternal feeling that prevailed, and inspired the delegates to take back to their chapters a message of co-operation with and confidence in the national officers.

The following national officers for the coming year were installed at the last meeting of the convention:

President, Dr. D. B. Steinman, New York City; vice-presidents, O. Laurgaard, Portland, Ore., and W. R. Harris, Chicago; acting secretary, M. E. McIver, Chicago; treasurer, H. W. Clausen, Chicago; directing manager, Harold Almert, Chicago. National directors, O. H. Kneen, Seattle, Wash.; Donald M. Baker, Los Angeles; C. J. Ullrich, Salt Lake City; H. A. Wagner, Mayer, Ariz.; A. A. Prendergast, St. Paul, Minn.; R. S. Kellogg, Chicago; A. G. Culverhouse, Birmingham, Ala.; H. J. Spelman, Huntington, W. Va.; A. M. Knowles, New York; E. I. Gardiner, Boston; Arthur Richards, Chillicothe, Ohio.

Details of Supreme Court Decision on Cement Trade Association

IN *Engineering New-Record*, June 4, 1925, p. 943, a résumé is given of the decision of the United States Supreme Court declaring the maple flooring and cement trade association activities not to be in violation of the Sherman Act. The full decision of the court is now available and from it the following details of the decision in the cement case are taken:

The case was an appeal of a final decree of the District Court for the Southern District of New York granting an injunction, under charge of violation of the Sherman Act, against the Cement Manufacturers Protective Association and its constituent members. (For lower court decision see *Engineering News-Record*, Nov. 1, 1923, p. 726.) That association sought and disseminated to its members information on credits, on specific job contracts, on freight rates for cement and statistical data on production, stocks and shipments. The court abstracts the performance of the association in each.

It concludes in regard to the specific job contracts that there was no basis for the contention that such activities constitute unlawful restraint of commerce and decides that the gathering and dissemination of information regarding specific job contracts would enable the sellers to prevent the perpetration of fraud upon them, which is permissible. With regard to the freight rate book, the court concludes that that, too, is a legitimate activity and the same conclusion is given as to the information concerning credit on the ground that this too cuts down possible fraud against manufacturers and they are permitted to take such steps as are desirable to prevent such frauds.

In regard to the gathering and reporting of information, the court says: "Nor can we regard the gathering and reporting of information through the co-operation of the defendants in this case with reference to production, price of cement in actual closed specific job contracts, and of transportation costs from chief points of production in the cement trade as an unlawful restraint of commerce, even though it be assumed that the result of the gathering and reporting of such information tends to bring about uniformity in price. Agreements or understanding among competitors for the maintenance of uniform prices are, of course, unlawful and may be enjoined, but the government does not rely on any agreement or understanding for price maintenance. It relies rather upon the necessary leveling effect upon prices of knowledge disseminated among sellers as to some of the important factors which enter into price. . . . We realize that uniformity of price may be the result of agreement or understanding and that an artificial price level not related to the supply and demand of a given commodity may be evidence from which such agreement or understanding or some concerted action of sellers operating to restrain commerce may be inferred, but here the government does not rely upon agreement or understanding and this record only fails to establish either directly or by inference any concerted action other than that involved in the gathering and dissemination of pertinent information with respect to the sale and distribution of cement to which we have referred, and it fails to show any effect on price and production except such as would naturally flow from the dissemination of that information in the trade and its natural influence on individual action."

Illinois Tornado Effects Studied by Engineers

Observations of Committee of Western Society of Engineers on Probable Wind Pressure and on Defects in Building Construction that Contributed to Loss of Life and Property

IMMEDIATELY following the great tornado that passed through southern Illinois on March 18, 1925, a committee of the Western Society of Engineers went over the devastated districts to observe the structural effects of the storm and determine what might be learned as to the action of tornadoes on structures and means of protecting against them. The committee rendered its report to the society on May 25. A summary of the salient features of the report is given in the following. General accounts of the tornado and of some of its effects were given in our issues of March 26 and April 9, pp. 522 and 609.

H. E. Young, F. A. Randall, Max L. Loewenberg and F. G. Vent constituted the committee. The field

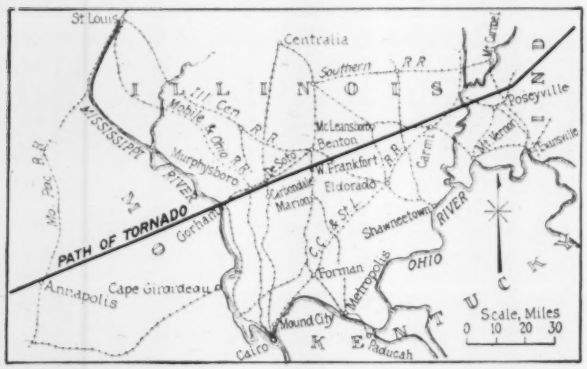


FIG. 1—PATH OF TORNADO OF MARCH 18 THROUGH SOUTHERN ILLINOIS

inspection was carried out on March 28 and 29, and covered mainly the cities of West Frankfort, De Soto and Murphysboro, Ill.

Course and Magnitude of Storm—On the afternoon of March 18 a tornado which formed over the southeastern part of Missouri moved in ENE direction across the southern part of Illinois and into Indiana. It originated about 1 p.m., struck Annapolis, Mo., at 1:15, and then moved in an almost straight path E 21 deg. N across the Mississippi River through Gorham (2:25), Murphysboro (2:34), De Soto (2:38), Bush (2:45), West Frankfort (2:54), Parrish (3:07), and Grossville, Ill. (3:50), and continued across the Wabash to Griffin, Ind. (4 p.m.), thence curving northerly through the edge of Owensville and finally through Princeton (4:18) ending near Porter at 4:35. Its path of destruction ranged from ½ to 1 mile wide, narrowing to ¼ mile after passing Princeton but continuing severe in effect for 7 miles.

In magnitude, as measured by destruction and death, the tornado was the largest on record in the United States. It killed more than 800 persons (more than 600 in Illinois). The property damage has not been computed but will run into millions.

From the observed times of incidence at the various points in its course the advance of the tornado is found to have been at practically uniform speed, averaging about 60 miles per hour for the total distance of 218 miles.

Records of tornadoes during the past two or three decades show Illinois and adjacent states, especially the prairie and plains regions to the west, to be closely gridironed by the paths of such storms. In most cases the paths were short—20 miles or less—so that the present tornado was remarkable for its length as well as for its width of path, the average width of tornado paths being about ¼ mile. However, one or two tornado paths even longer than the present one have been recorded in this region.

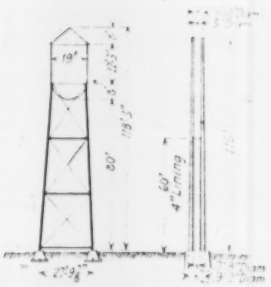
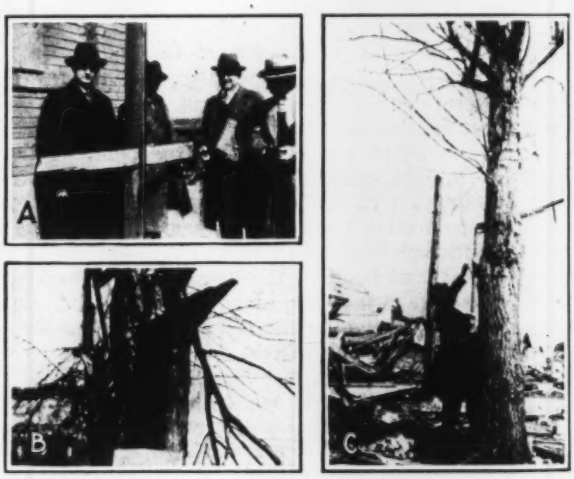


FIG. 2—STEEL WATER TANK AND CONCRETE CHIMNEY AT WEST FRANKFORT

Wind Velocity — Definite observations of helical formation of the storm are not reported and the observed destruction gives little evidence of twisting. Most of the effects seemed to be those which would result from a direct wind moving practically from south to north (i.e., at an angle to the course of the storm). This direction is indicated by pressure effects such as collapsed sides of tanks, the direction of fallen trees and houses, and velocity effects as shown by splinters driven into trees and other objects. But the committee cites as one proof of helical motion of this storm the fact that, while its bodily speed was only 60 mi. per hr., "the velocity of the wind, in order to do the damage it did, has been conservatively estimated at 200 mi. per hr. or more." The committee's

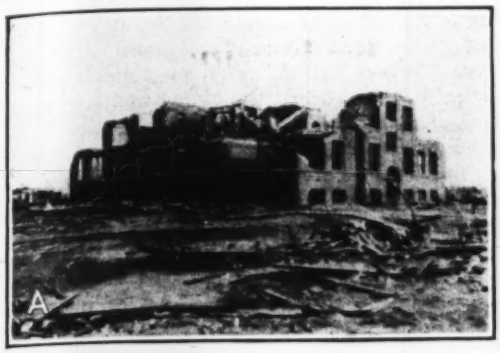


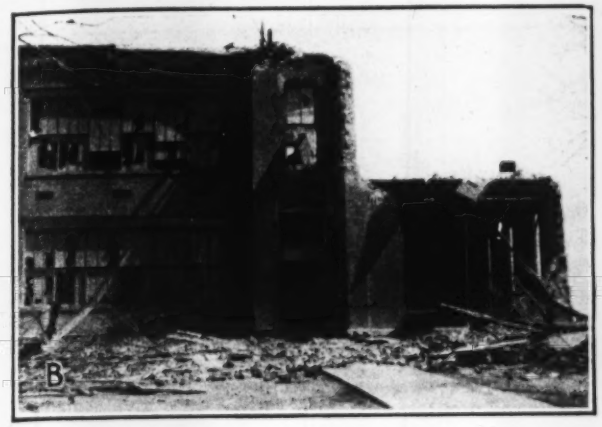
A. Pine board, 1x5 in., driven through 2x6 pine plank. Leading end of board contained a beveled knot; end not battered by its penetration. Tongue along edge of board plowed a clean furrow through the plank.

B. Board 1x8 in. blown due north into a maple tree to depth of 5 in. Able to hold up a man hanging on the free end.

C. Hard pine stick 2x1½ in. driven entirely through an 18-in. poplar. Direction due north; tree located 50 ft. north of undamaged house, and half a block south of Murphysboro high school.

FIG. 3—PROJECTILE EFFECT OF DEBRIS CARRIED BY TORNADO





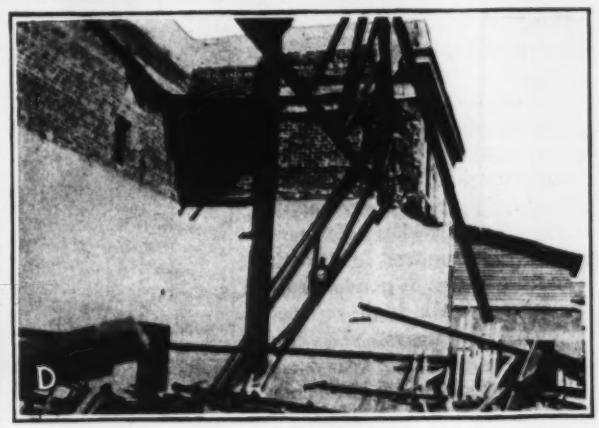


FIG. 4
SOME DESTROYED SCHOOLS AND CHURCHES

A. Longfellow school, Murphysboro, seen looking northeast.

B. Logan school, Murphysboro.

C. Murphysboro High School, west wing.

D. North truss of gymnasium still in place.

E. End of gymnasium roof trusses torn from wall with their concrete seating blocks.

F. Ruins of Baptist Church, Murphysboro.

G. Public School at De Soto.

estimates and recommendations as to wind pressure are quoted farther on.

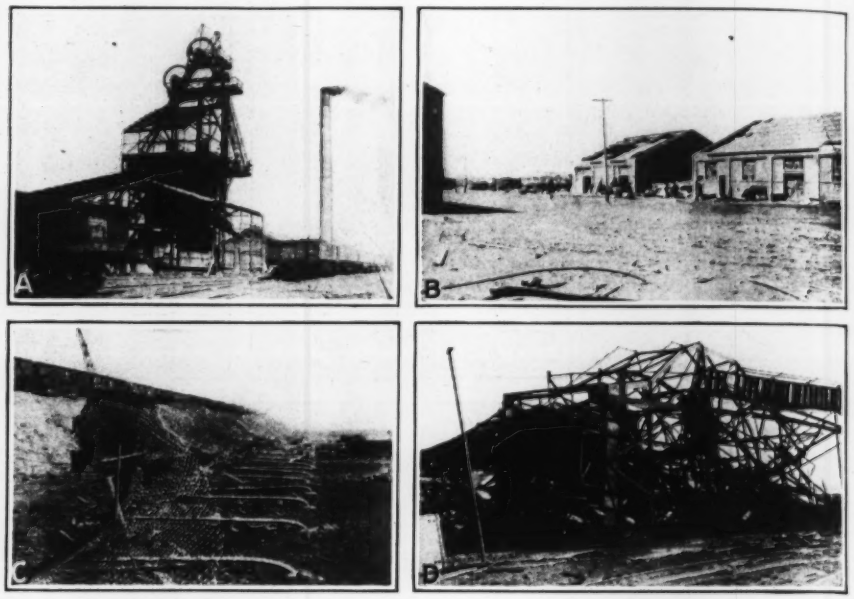
Mine Structures—The severity of the effect of the storm on even well-built fireproof structures is illustrated by the case of the administration building at Orient Mine No. 2, West Frankfort, Ill., a modern plant, whose structures as a whole resisted the storm very well. Many missiles were blown through the walls and doors of the building, the windows on the south and west faces were blown in and those on the north and east faces blown out, except that those of the northeast room on first and second floors remained intact. Most of the steel sash in the windows held, which to a great extent protected the interior. Partitions were blown down, skylights were blown off the building, and the roof flashing was damaged. The south face of the building was completely covered with a gray mud, a phenomenon that was observed elsewhere also. Near this building several automobiles were blown distances of several hundred feet north, and the bodies of gondola railway cars on a high railroad embankment near the building were either overturned or blown off sideways. The committee states at this point, "In a number of instances extremely large and heavy objects appeared to have been lifted bodily into the air, carried a considerable distance, and then deposited lightly."

A 60,000-gal. water tank near the administration building, supported on columns 85 ft. high, was destroyed. This is referred to later. The condition of the anchor bolts was taken to show that the windward anchorage failed in tension, while the leeward bolts showed failure in tension coupled with slight bending. While the committee analyzes the case as one of direct lateral pressure, it remarks that "a study of the failure of a great many structures in the tornado district indicates that there must have been a terrific uplift."

The store-room building at this mine (view *B*, Fig. 5) represents fairly the resistance of substantial industrial structures. This building had brick walls laid in cement mortar, steel roof trusses and cement-tile roof. Several windows were blown out, doors were blown in, and a portion of the tile roof was torn off. In a few similar buildings at the plant, walls or parts of walls were blown over. A 20-ton locomotive crane on an elevated track nearby was lifted off the tracks and laid against a building. A reinforced-concrete smokestack did not fail and on close examination showed no defect chargeable to the tornado. This stack also is referred to farther on. A steel fence at this mine was blown over, the posts being bent northward flat to the ground (view *C*, Fig. 5).

The auxiliary hoist tipple of Orient No. 2 (view *A*, Fig. 5) was in the path of the storm, buildings on both sides of it being destroyed, but survived excellently and was in operation 15 min. after the storm. Siding and roof of corrugated zinc were blown off, but the anchorage nowhere failed. The main tipple and the rescreening house also had the siding and roof largely blown off. The tipple could be put in operation directly afterwards and required little repair. The rescreening building, which is narrow, had large steel bin sides which presented much resistance to the wind; in consequence, the column base plates on the leeward side were dished as much as ¾ in., and the entire diagonal bracing on the north side was twisted and bent; the structure was deflected about 1 in. out of plumb, but no tension failure on the windward side was found.

Peabody Mine No. 18, 6 miles northeast, had its surface structures destroyed. They were 20 years old and much weakened by corrosion. The tipple (view *D*, Fig. 5) was overturned to the north; the windward columns pulled loose or pulled out of their footing piers, which were pyramidal concrete blocks 3 ft. square and 3 ft. deep, and in general broke at the bottom of the anchorage. The anchor bolts were about 1¼ in. in diameter, with anchor plates 5x10 in. and ¾ in. thick. The tipple columns consisted of 8x8x¾-in. angles with base plates 24 in. square by ⅞ in. thick. A 7-ft. radial brick chimney was wrecked together with boiler and engine room.



A. Auxiliary tipple at Orient No. 2 mine, stripped of zinc sheathing
B. Roof stripped from storage at New Orient mine.
C. Steel fence blown down; posts overturned toward north.
D. Tipple of Peabody No. 18 mine overturned and wrecked.

FIG. 5—TORNADO EFFECTS ON SOME MINE STRUCTURES

Fig. 7 shows the destruction of the shops of the Mobile & Ohio R.R. at Murphysboro, swept by both storm and fire; and the Illinois Central R.R. bridge over the Big Muddy River just south of Ziegler, Ill. This is a single-track through pin-connected structure of 158½-ft. span, of total weight slightly more than 100 tons. The north end of the bridge was moved 6 ft. to the east, the shoe hanging just over the pier; the south end of the bridge was moved eastward 21 in. The entire bridge was also moved 8 in. to the north.

Commercial Buildings and Dwellings—Destruction of both frame dwellings and commercial buildings, the

latter usually of brick-wall and wood-joist construction, was quite general. The effect is best shown by view *A*, Fig. 6, showing a section of Murphysboro. That brick buildings of "ordinary" construction did not display much resistance is instanced by the wrecking of the First National Bank at Gorham, Ill. The heavy brick vault was undamaged, while the bank around it was demolished. A concrete-wall bakery in Murphysboro, two stories high, had the upper story blown down (wall thickness 6 in., with 3x13-in. pilasters every 10 ft.). The second floor, of wood-joist construction, held intact.

The behavior of ordinary construction is also illustrated by view *A*, Fig. 8, showing the Brown Shoe Factory at Murphysboro, which had its roof taken off, although it was not in the main path of the storm.

A special illustration of the weakness of frame buildings is given by view *B*, Fig. 6, showing the wrecking of a wooden church which was about a mile distant from the path of the storm, and near a number of houses which show no trace of storm injury. However, that the wind exhibited strong local irregularities is instanced by the view *C*, Fig. 3, showing a stick of wood driven completely through an 18-in. poplar tree in due northerly direction, although the tree was located 50 ft. north of a house which was not damaged.

A. Ruins of residential part of Murphysboro.

B. Wooden church, one mile from path, moved 20 ft. off foundation.

FIG. 6—STORM ACTION IN AND OUTSIDE OF THE PATH

Public Buildings—Destruction of schools noted in the report covers the De Soto public school, the Longfellow and Logan schools in Murphysboro, and Murphysboro High School (views in Fig. 4). Many children were killed in the destruction of these schools. Serious defects in construction are reported to have contributed materially to the failure of the structures. A related item is the destruction of the Baptist Church in Murphysboro (view *F*, Fig. 4).

The De Soto school was of ordinary brick construction, the brick poorly bonded; in particular the face brick of the east wall lacked practically all bond to the backing. The joists were not anchored to the walls or the roof to the joists, and the building is reported as "absolutely devoid of any adequate means of bonding the various parts together." The first-story walls were 17 in. thick, the upper walls 13 in. thick, the joists 2x12 in. The upper story was completely blown off and 33 children were killed. The south face of the building was covered with gray mud.

Logan school, in Murphysboro, was also a two-story brick building with wood floor construction. The northeast room of the second floor was not damaged, but the south and west sides were badly ruined. Here, also, there was absolute lack of bond between floors and walls, the brickwork showed 16 courses of brick without bonding, there were no ties throughout the building; "the utter collapse of the Logan school was undoubtedly due to the absence of bond between the floors and walls, pilasters, lack of bracing, anchorage of roof, etc."

The Longfellow school (view *A*, Fig. 4) had 21-in. walls in the first story and 17-in. in the second story. The interior walls exerted a strong bracing effect and remained standing. All rooms on the second floor were demolished except for two at the center of the building; the northwest corner room on the first floor had the north wall and west windows blown out, and the southwest rooms in the first story were demolished. The floor joists lacked anchorage. Seventeen children were killed in the building.

Murphysboro High School (view *C*, Fig. 4) had an old central portion and newer east and west wings. The gymnasium, in the west wing had its roof supported on steel trusses resting on high walls. The walls above the floor in the gymnasium were completely demolished. There were no pilasters under the roof trusses, and the only support and anchorage of the trusses was a small block of concrete under the bed plate of each truss (view *E*, Fig. 4). The trusses were blown about 20 ft. to the east. One roof truss framing into the return walls of the main or central portion of the building remained in place.

The Murphysboro Baptist Church was destroyed as completely as the school buildings (view *F*, Fig. 4). This structure had not been quite completed.

Other Structures—Two steel grain tanks 24 ft. in diameter by 60 ft. high at Murphysboro are shown by view *B*, Fig. 8. The south side of the south tank was crushed in by the wind, while the north tank was practically uninjured. A wooden building between the two tanks burned, and heated the plates of the tank so that they buckled, in addition to setting the grain in the tanks on fire. The plating of the south tank was pulled out of the foundations about ½ in., and the south side of the north tank was also torn loose.

Reinforced-concrete coal pockets 12 ft. in diameter by 40 ft. high, a short distance north of these grain tanks, were apparently uninjured. They were located in the central part of the path of the tornado. Timberwork in the 3-ft. space between the two pockets remained in place.

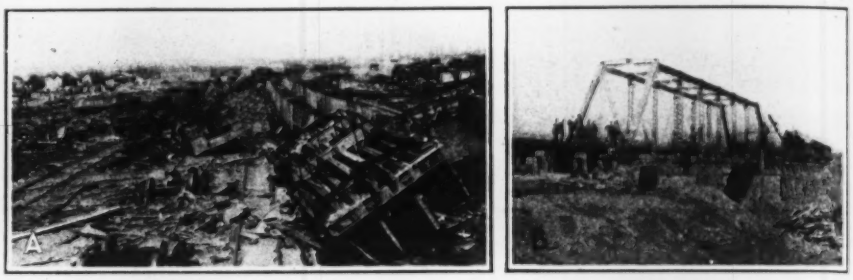
A number of concrete farm silos which were not damaged by the tornado are illustrated in the report. View *D*, Fig. 8, shows one of them. In several cases structures nearby were destroyed.

Trees in the path of the storm were in many cases broken off or stripped at or above a general level 8 or 10 ft. from the ground. In some instances trees acted as protection to houses, notably so in the case of the Albin home, a frame dwelling of two stories in De Soto, which stood in the center of a circle of large oak trees (17 to 48 in. diameter, and 15 to 30 ft. apart). The trees had their crowns broken off about at the level of the top of the house, but seem to have protected the house, which was little injured except

for the blowing in of south and west windows. A barn just southeast was demolished. A house just north was little damaged, but the De Soto school, north of this, was destroyed.

Estimates of Wind Pressure—The committee found the best basis for estimating wind pressure in the destruction of the elevated water tank at Orient Mine No. 2, and the resistance of the nearby concrete chimney. Outline drawings are given in Fig. 2.

The water tank was a hemispherical-bottom steel tank of 60,000 gal. capacity and of 118 ft. 3 in. height from base of columns to peak of roof. The tank was 19 ft. in diameter, and the spacing of the four columns at the base was 27 ft. 9¾ in. c. to c. Each column was anchored to its pedestal with one 1¾-in. anchor bolt extending 5 ft. down. Each pedestal was 7 ft. square at the footing course, 3½ ft. square at the top, resting on an 8-ft. square footing course 1 ft. thick, the bottom of the footing being 5 ft. below ground or 6 ft. below top of pedestal. The structure was built by the Chicago Bridge & Iron Co. The tank had ⅜- and ¼-in. shell, ½-in. bottom, and ¼-in. roof. A steel water column of ½-in. metal extended from the bottom of the tank to a central concrete pedestal at the ground line. The columns were built of two 12-in. channels each, the struts of two 7-in. channels and two 6-in. channels respectively, while the diagonal bracing was 1¼-in. rods. The structure was proportioned for a wind pressure of 50 lb. per sq.ft. on six-tenths of the projected tank area. Its weight empty was 75,000 lb.



A. View in the M. & O. R.R. yards at Murphysboro.

B. Illinois Central bridge that was shoved off its bearings.

FIG. 7—SOME ITEMS OF RAILROAD DAMAGE

The committee finds that the tank was intact when it landed on the ground, the impact bending two of the bottom plates. "All four anchor bolts show tension failure. The tank was blown in a northerly direction to a position just north of the two north column foundations and midway between them. A study of the anchor bolts indicates that the anchorage on the windward side failed in tension, and that the other bolts in addition to failure by tension indicate a slight bending." The southwest anchor bolts remain practically vertical, the southeast bolt was bent slightly in a northerly direction, and both show decided necking. The concrete pedestals were apparently in good condition. The north corner of the southeast column bearing plate was bent up at an angle of about 45 deg. The northeast column was buckled, twisted and buried in the ground, its base badly bent and twisted. At this column the nut remained in place on the anchor bolt.

To estimate the wind pressure the committee disregards uplift and computes the overturning action as due to direct lateral pressure. Assuming the ultimate strength of the anchor bolts to have been 56,000 lb. per sq.in., it finds an ultimate resistance equal to a pressure of 120 lb. per sq.ft. on tank and tower, for the empty tank, and a corresponding failure strength of 250 lb. pressure for full tank. However, the tower bracing rods would fail under a wind pressure of 110 lb. per sq.ft., and after failure of the lower rods the northeast column could have failed under a slight pressure.

Coming to the nearby concrete chimney, which did not fail, the committee gives its dimensions as 9 ft. 2 in. bottom diameter and 5 ft. 10 in. top diameter outside, height above foundation 117 ft., or 115 ft. above ground. The chimney was of 1:2:3 concrete, reinforced with 35 ¾-in. vertical rods at the base, with ½-in. horizontal bars 12 in. on centers. Assuming six-tenths of the diameter as equivalent flat surface for wind exposure, the committee computes the ultimate resistance of the stack as 206 lb. per sq.ft.

Conclusions from Study

The committee states that while there was evidence of unusually low pressure in the path of the tornado, most of the damage appeared to be due to direct pressure rather than vacuum or explosive force, and the conclusions relate largely to this pressure force. They are quoted below with only slight condensation.

General Conditions—Field inspection indicated a surprisingly lax manner of construction, very markedly so for a tornado zone. Apparently little or no thought was given to anchorage details. In most cases there were no ties between floors and walls, roofs and walls, joists and walls, sills and foundation walls; and even face brick was laid up without even the usual bonding to the common brick backing.

Frame Construction—The builder in the tornado region should bear in mind the need of construction to resist excessive wind pressures, the same as a builder in a northern climate builds to resist severe cold. Certain simple features such as bolting the sills to the foundations, securely anchoring the plates, joists, studs, rafters, etc., as well as tying the corners, add an inappreciable amount to the total cost of even the cheapest type of structure. Such added precaution reduces the liability of damage from ordinary wind storms and may even resist the forces of less intensity along the edges of a tornado. The saving due to even such minor precautions would probably run into a startling figure in a tornado of the extent of this one.

The cheap frame-house of the type commonly set on posts in warmer climates should at least be set on concrete piers. These piers will not only serve as anchorage but almost justify the slight additional expense by saving in maintenance. The sills should be mitered and securely anchored to these piers. The larger the piers, the better; in fact a continuous wall would be most desirable. If only piers are used, the space between them should be closed. This will resist the wind tending to get under and lift the building.

A next step that would add but little to the total cost would be to extend anchors from the concrete piers up between the studs and connecting to the plates or even to the roof framing. Such anchors at frequent intervals would supplement the usual more or less casual nailing of the studs to sills and plates. Strap-iron ties should be used to secure the rafters to the plates. In all cases studs should be continuous from sill to rafter plate.

The next and a no less vital feature is bracing. The average builder considers the nailing of sheathing and siding to one side of a row of studs, and laths to be coated with plaster on the other side, as a rigid system of bracing.

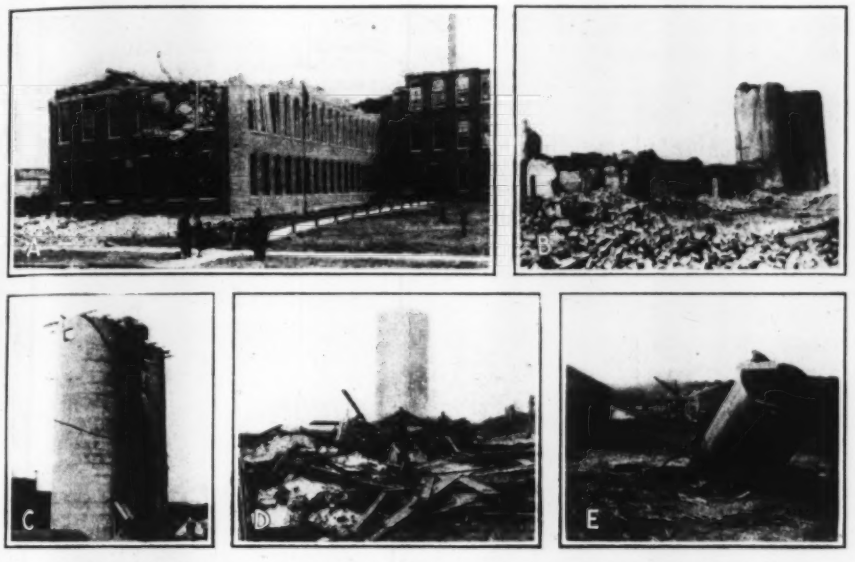
It is true this serves well, but it can never compare with a systematic and well planned system of bracing. In walls that are not cut by window or door openings, the bracing should extend diagonally from one corner of the wall to the opposite side, in both directions. This may be accomplished by bridging between the studs, by tie rods or bolts, or by tie straps. The straps may be made of lath thickness, and securely nailed to the face of the stud. This method of bracing applies to interior partition walls as well as to exterior walls. The designer and builder should bear in mind the necessity of having vital points, like brace reaction points, partition and sidewalls alike, securely attached. In cases where openings cut the walls, the bracing will of necessity be in knee-brace form or like tower bracing at the sides of the openings.

The value of inside partitions as a system of bracing is an especially vital feature in the case of walls having face-brick surfaces. Header courses should be laid in at least every fourth course.

It is difficult to build in many ties and braces. For that reason special consideration should be given to cross-walls, stair walls, elevator inclosures and the like. An interior wall should be bonded securely to other walls at every point offering the opportunity. In this devastated area walls of this nature were found to have served to good advantage. The use of brick dividing and partition walls instead of tile or frame partitions may serve to save the structure. In all cases brick walls should be laid up in cement mortar.

The anchoring of columns, girders, joists and roof construction is of vital importance. The inspection indicated a gross negligence in connection with such details.

At least the boiler room should be of concrete construction with a reinforced-concrete slab above. It is much better to have the entire first floor, over the basement, of reinforced-concrete construction and securely anchored to the foundation walls.



A. Brown Shoe Factory, Murphysboro. In rear are concrete stack and wooden water tank still standing.
B. Steel grain tanks crushed in on south side
C. Concrete coal bins undamaged.
D. Concrete silo uninjured, farm buildings destroyed.
E. Elevated water tank at Orient mine.

FIG. 8—FACTORY AND STORAGE STRUCTURES AFTER THE TORNADO

Mill Construction — In slow-burning or mill construction the foregoing precautions as to foundations, pilasters, anchorage, and the like should be carefully considered. This type of structure is in general more rigid than ordinary construction, but is commonly used only in larger structures. It is certainly justifiable to have the basement and the first-floor slab of reinforced concrete, securely anchored to the foundation walls. All columns should be securely tied together and anchored. Girders in all cases should be anchored continuously from wall to wall and into the walls, and should also be securely anchored to columns. Every other line of joists should be anchored together and into the walls. The roof construction should be anchored in a similar manner.

cannot be overestimated, provided the loads are properly conveyed into the outer walls and into substantial footings.

In order to improve on this type of construction from the standpoint of safety, a small cellar of concrete properly reinforced may be built. The next improvement and one most highly recommended is a basement under the entire house, constructed of concrete and having a reinforced-concrete floor above for the building's first floor.

A type of architecture might well be developed along the Spanish style, suitable for tornado zones. Studies along that line would tend to eliminate projecting cornices, overhanging eaves, and similar features that act as wind pockets.

Business Buildings—What is termed ordinary construction—concrete foundations, brick walls, and timber floor and roof construction—is most commonly used for commercial and industrial as well as small community buildings. It was this type of structure that caused the largest loss of life in the recent tornado. In general appearance it is durable and substantial, and most people feel that it is a type of structure suitable for refuge. When it fails, the brick walls crumble and fall in heaps, crushing the occupants.

Brick walls must be on a good substantial foundation. The foundation should be amply wide to give full bearing to the walls, and should be designed to take safely not only the direct load but also stress due to eccentric load or overturning tendencies. The walls should be fully reinforced with pilasters; even single-story walls should be so reinforced. Pilasters should be not less than 17 in. thick, and of width not less than ¼ their spacing. Special provision should be made for unusual story heights and long, free standing walls. A vital point is thorough bonding. This

Fireproof Construction—The fireproof type should be used for all public buildings such as court houses, city halls, schools and similar structures. It divides into two classes: wall-bearing and skeleton. Skeleton construction properly designed will undoubtedly resist a severe storm. Wall-bearing construction should receive special consideration in line with the foregoing recommendations. The designer should bear in mind the possibility of abnormal loads, and provide ties, bracing, anchors, etc., accordingly. The type lends itself readily to a system of ties from roof to foundation. Even in the wall-bearing type, a slight additional expense would be justified to run reinforced-concrete piers from roof to footing as a tie to make the structure a unit.

Miscellaneous Structures—Tanks, water towers, stacks, silos, tipples and the like are comparatively expensive structures. Liberal wind bracing and anchorage add only a small percentage to the cost. Such structures are usually in open, exposed and often elevated localities. The designer and builder should bear these features in mind. The arbitrary addition of a small percentage to anchor bolt areas, and the provision of extra rivets in the bracing connections, are negligible items of expense and may save the structure.

Design Recommendations—In conclusion the committee further recommends that in the areas subject to tornadoes, a designing wind pressure of 65 lb. per sq.ft. be used, with a factor of safety of 4; that the weight of the structure be divided by the factor of safety of 4 before entering the weight into the calculations for stability; that special consideration be given to anchorage and wind-bracing details of construction; and that normal deterioration of anchors and bracing be considered.

From Job and Office

Hints That Cut Cost and Time For the Contractor and the Engineer

Top Slab of Culvert Carries Walls of Bank Built Over Creek

By N. H. Sturdy
Manager, Educational Department, Truscon Steel Co., Youngstown, Ohio

THE site for the new building of the First National Bank of East Palestine, Ohio, is a lot 33 ft. wide, through the entire length of which runs a small creek.

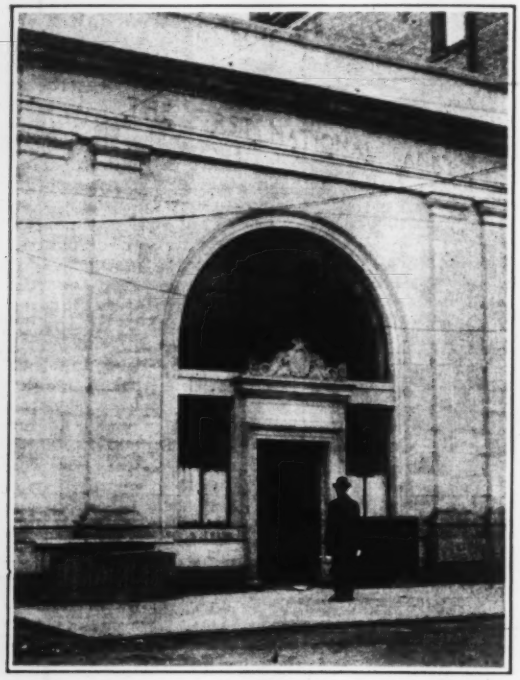


FIG. 1—VIEW OF BANK BUILT OVER STREAM

Before the bank was built, the street pavement had been carried over the creek on structural steel girders, spanning approximately 30 ft., placed entirely below the paving slab.

The stream has a comparatively small maximum flow, a culvert approximately 8 ft. x 8 ft., a short distance upstream, having proved adequate for a number of years. On the north side of the property is a three-story and basement brick building erected about thirty-five years ago. The foundation walls are of rubble masonry with the footing course located several feet above the bed of the stream. Had the usual methods of construction, requiring the exterior walls of the building to be carried to a firm foundation below the bed of the creek, been used, it would have been necessary to shore, underpin and extend the walls of the old building to the same depth as the walls of the bank building, involving possible danger and certain undue expense. As the bank building was to be only one story in height it was suggested that a culvert be built in the bed of the stream, the top slab extended to the

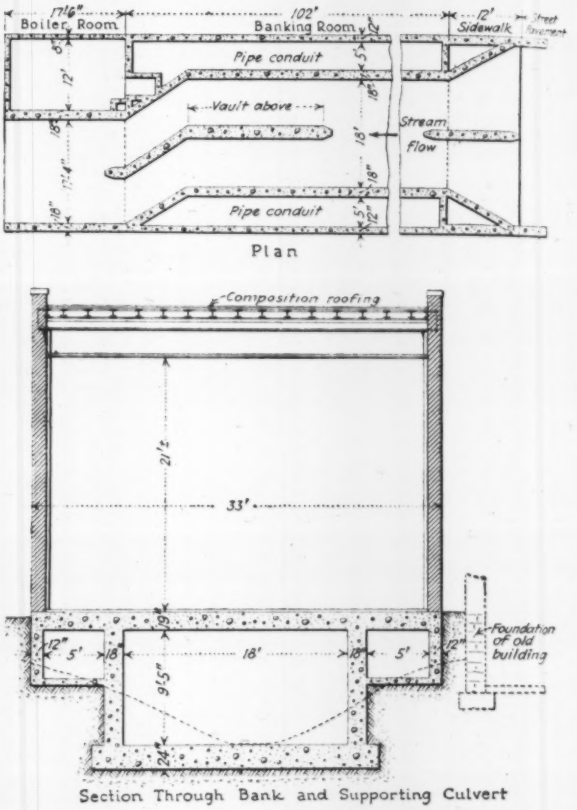


FIG. 2—CROSS-SECTION AND PLAN OF BANK BUILDING

property lines and designed to carry the weight of the sidewalls and roof by cantilever action. This would obviate the necessity of excavating near the foundation of the existing building.

Studies of this suggestion were made and it was found possible to develop a design to carry the loads which would be applied. The walls of the culvert were made parallel with the property lines for a distance of 90 ft. 6 in. from the front of the building, then deflected to the left and directed into the natural course of the stream. This provided space for a boiler room

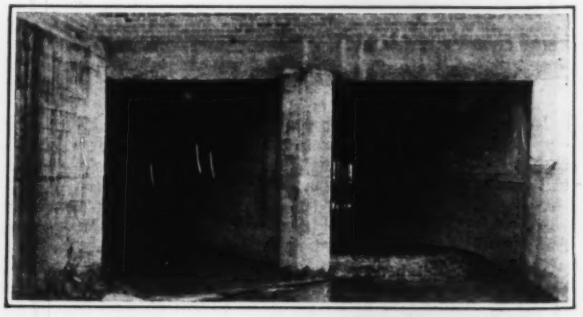


FIG. 3—VIEW OF CULVERT AT REAR OF BUILDING

at the rear at an elevation lower than the banking floor. The spaces on each side under the cantilevered slabs were enclosed with reinforced-concrete walls providing tunnels, which are used for placing and inspecting the heating pipes.

In carrying out the studies of the structural design it was found that, with the uniformly distributed floor dead-load and the heavy concentrations at the ends of the cantilevers, the addition of a partition wall dividing the culvert into two sections would be detrimental.

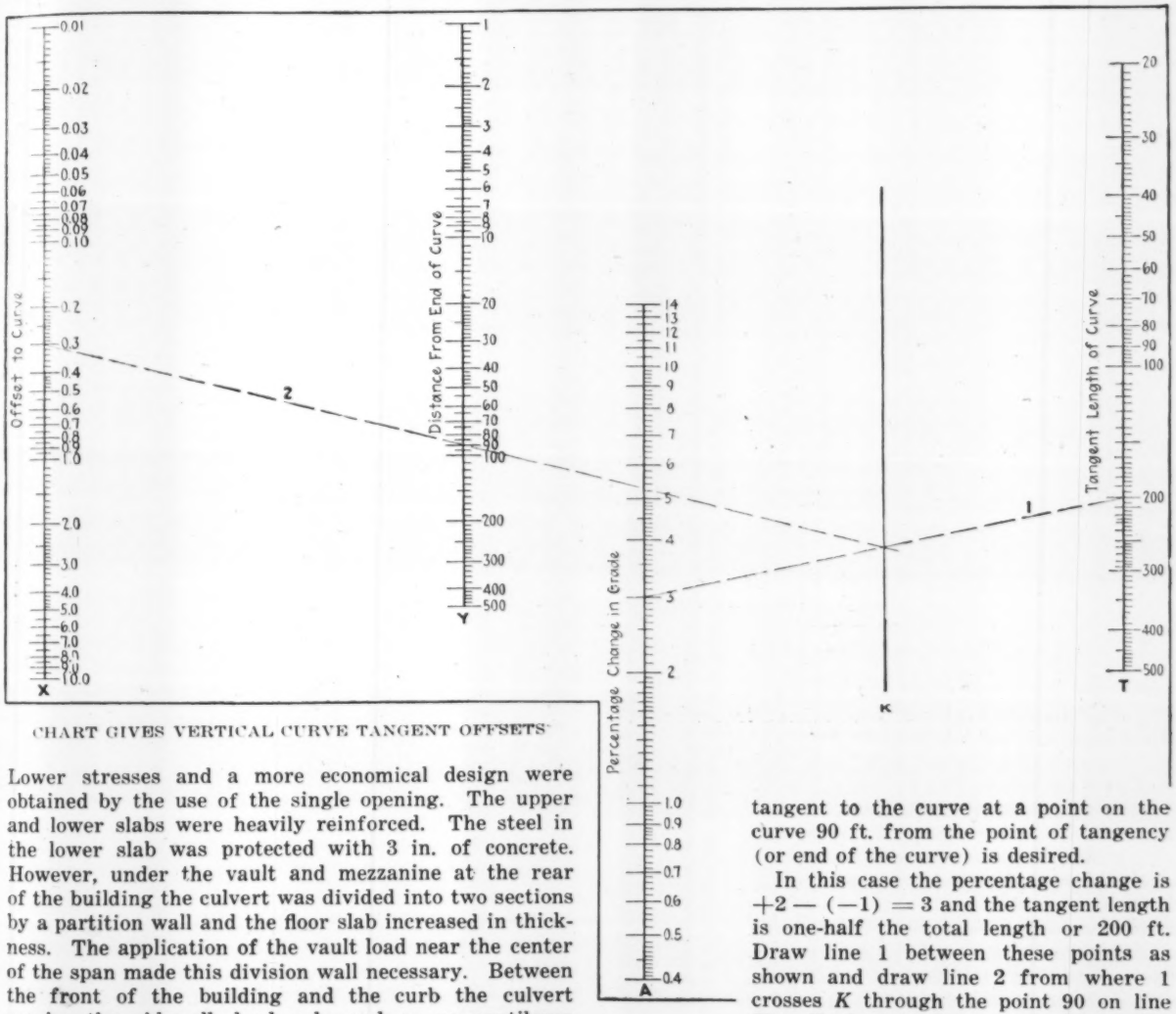


CHART GIVES VERTICAL CURVE TANGENT OFFSETS

Lower stresses and a more economical design were obtained by the use of the single opening. The upper and lower slabs were heavily reinforced. The steel in the lower slab was protected with 3 in. of concrete. However, under the vault and mezzanine at the rear of the building the culvert was divided into two sections by a partition wall and the floor slab increased in thickness. The application of the vault load near the center of the span made this division wall necessary. Between the front of the building and the curb the culvert carries the sidewalk load only and as no cantilever action is present the culvert is divided into two sections for this distance.

During construction the stream was carried by a flume to the south of the culvert until the floor and walls had been poured. The foundation is hard compacted gravel. Two small pockets of quicksand were encountered; but they were excavated and filled with concrete.

The building was constructed under the direction of C. G. Kistler, architect, Kent, Ohio; the concrete work was done by Benzenhæfer & Garside, contractors, East Palestine, Ohio; and the reinforcing steel and the design of the structural frame by the Truscon Steel Co., Youngstown, Ohio.

Nomogram for Solution of Vertical Curves

By Merritt P. Smith
Medford Hillside, Massachusetts

THE chart herewith reproduced has been arranged to accommodate particularly the highway grades usually encountered but can easily be used for the flatter grades and longer curves of railroad work.

Use of Chart—Let us suppose that a vertical curve 400 ft. long is to be placed between a +2 per cent grade and a −1 per cent grade. The vertical offset from the tangent to the curve at a point on the curve 90 ft. from the point of tangency (or end of the curve) is desired.

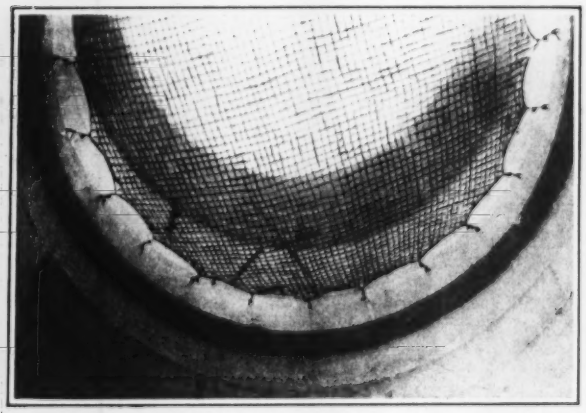
In this case the percentage change is $+2 - (-1) = 3$ and the tangent length is one-half the total length or 200 ft. Draw line 1 between these points as shown and draw line 2 from where 1 crosses K through the point 90 on line Y to X, obtaining as a result 0.30 as the offset to the curve.

It will be noticed that line 1 is the same for any one curve and offsets may be obtained at as many points as desired by revolving line 2 about the point found on line K.

Reproduction of Chart—The chart is based on the formulas $X = KY^2$ and $K = A/400T$. All scales are logarithmic. Scale of T is exactly that of A, and K is equidistant from A and T. Scale of Y is one-half that of T with 100 opposite a point on K obtained by drawing line 1 from $A = 4$ to $T = 100$. Scale of X is the same as Y and directly opposite. Y is equidistant from X and K. Values of A should increase in the opposite direction from those of T, X and Y.

Rope Net in Surge Chamber Safeguards Workmen

THE surge chamber for the Moccasin Creek plant on the Hetch Hetchy project is a concrete structure standing 48 ft. above ground level. Inside, however, the distance through which a workman would fall if he slipped into the chamber is 160 ft. In order to safeguard men working on the top of the structure, a light net made of Manila rope was made up on the job and stretched just below the level where the workmen were engaged. This not only avoided danger of serious accidents but is said to have speeded up the work as the men moved about with more confidence.



NET IN MOCCASIN CREEK SURGE CHAMBER

The net was made by laying out ropes of desired length on the ground and tying them together with heavy twine at points where they crossed, and attached around the edge to U-bolts purposely left in the concrete.

Three-Tier Grade Separation in San Diego, Calif.

A DANGEROUS intersection in San Diego where the steam railroad line was crossed at grade by electric railway as well as by a trunk highway has been eliminated by a grade-separation project that puts the highway below and the electric railway above the steam line, as shown in the accompanying illustration.

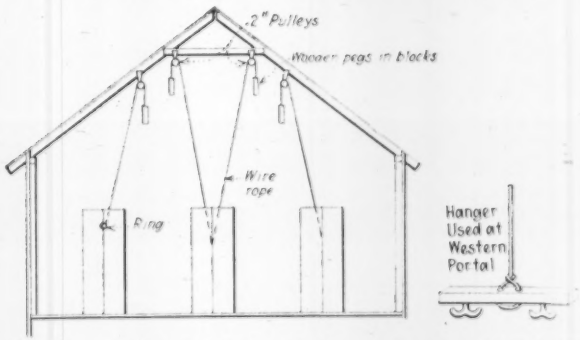
Both the electric railway and the highway made a sharp bend at a point near the intersection. In the case of the highway, this was taken care of by putting in two turns that approximate right angles thus giving a right-angled crossing. A portion of the subway under the railroad is below the water plane and hence the concrete slab forming the roadway was continued up the sides of the cut and constructed of sufficient thickness and weight to withstand the hydrostatic load. Surface water flowing into the depressed roadway is collected in a sump and pumped out by an automatic motor-driven pump.

The electric railway, on the other hand, did not desire to put in the sharp curves necessary to get a right-angled crossing, so selected an intersection with the steam line on an angle of 27 deg. This required 110-ft. girders to cross a distance of 45 ft. between the faces of supporting piers. This spacing between the piers was determined by the requirements of the present single-track steam line plus provision for two more tracks.

From Job and Office

Hints that Cut Cost and Time

Clothes Drier for Tunnel Workers



ONE of the principal features in the construction of the clothes driers for laborers in working on the Moffat tunnel through the Colorado Rockies was insurance against theft of clothes while drying. As shown in the accompanying sketch, a rope was run from each locker to a pulley suspended from the ceiling or from a hanger rod. To the end of these ropes wooden blocks, with wooden pegs in them, were fastened for holding the clothes. As the ropes ran through the tops of the various lockers, only the man to whom the locker belonged had easy access to his clothes hanging near the ceiling.

THREE-TIER GRADE SEPARATION AT SAN DIEGO

The overhead crossing is for the electric railway line. Abandoned highway crossing at right. Note length of piers supporting electric railway girders made necessary by sharp intersection angle of 27 deg.

From Job and Office

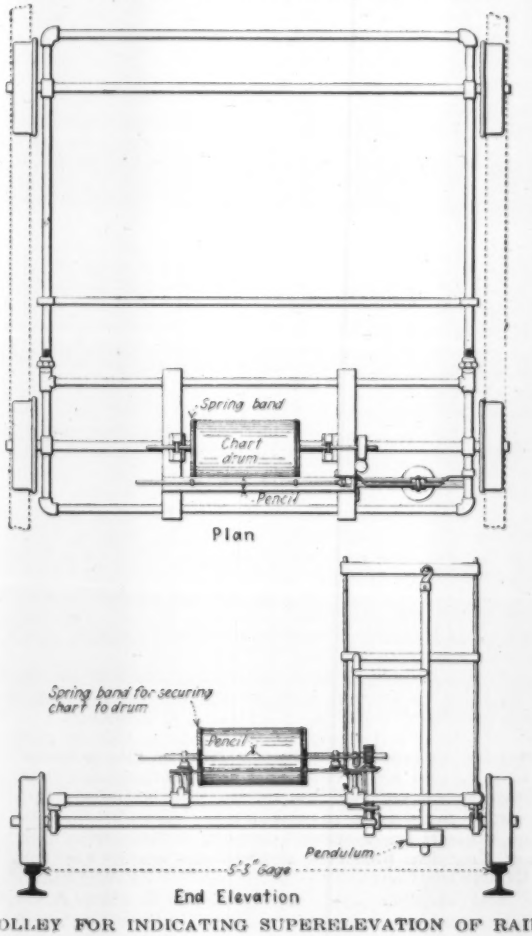
For Contractor and Engineer

This bad angle necessitated a large amount of excess concrete in the piers which did not serve any structural purpose; accordingly, forms were used to hollow out the piers, thus saving a considerable yardage of concrete. Some 15,000 cu.yd. of earth were placed in the embankment approaches to the overhead crossing, most of which is shown in the right background of the accompanying illustration. The frame trestles and steel girders were designed for Cooper's E-50 loading.

The structures which carry the electric railway tracks were constructed under the supervision of the San Diego Electric Railway Co., and the highway relocation was done under the supervision of the Atchison, Topeka & Santa Fé Railway Co.

A Device for Indicating Superelevation of Rail on Railway Curves

AN APPARATUS for indicating the conditions of the superelevation of the outer rail on railroad curves is described by William J. Sheldon, in a communication to the Institution of Civil Engineers, England. The apparatus was designed for use on the São Paulo Railway Co. of São Paulo, Brazil, of which Mr. Sheldon is chief engineer. The mechanism, shown in the accompanying figure, is mounted on a four-wheeled trolley of light construction, its total weight being 220 lb. for the 5 ft. 3 in. gage of this railway, and it can easily be propelled by one man. The apparatus is driven from the axle of the trolley by worm gearing which rotates the drum to which is attached the chart for recording the exact distance traveled along the curve. A pendulum device indicates automatically on this chart the superelevation which exists on the curve investigated.



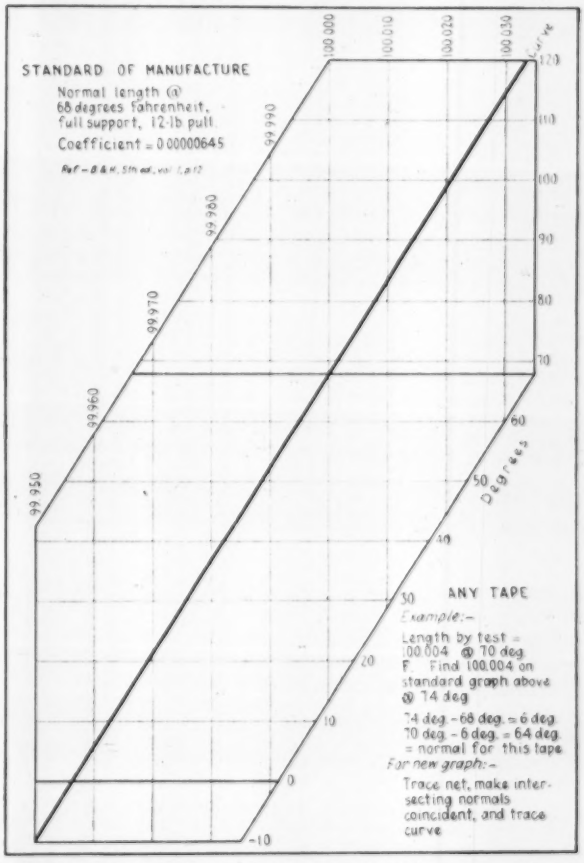
TROLLEY FOR INDICATING SUPERELEVATION OF RAILS

The gearing on the axle which rotates the chart drum is arranged so that the scale of reductions to which the movement of the trolley is shown is 1/1,000. The drum is 20 cm. in diameter, so that 600 meters of curve can be recorded on the chart with one revolution of the drum. The rotation of the drum can be put out of action, when traveling over a stretch of straight track, by loosening a thumbscrew which connects it to the spindle.

The chart pencil is attached to a sliding bar, which is operated by the action of the pendulum and indicates on the chart to a natural scale the exact superelevation of the curve investigated. The chart is secured to the drum at the ends by circular steel bands which can be detached from the drum in a few seconds.

The trolley is made in two parts, which enables it to be easily transported in the baggage car of a passenger train to any part of the railway, as the heavier part only weighs about 150 lb.

Steel Tape Contraction and Expansion


STANDARD OF MANUFACTURE
Normal length @ 68 degrees Fahrenheit, full support, 12-lb pull
Coefficient = 0.00000645
Ref – B & H. Sheldon, vol. I, p. 12
100.000
100.010
100.020
100.030
99.990
99.980
99.970
99.960
99.950
Degrees
ANY TAPE
Example:–
Length by test = 100.004 @ 70 deg. F. Find 100.004 on standard graph above @ 74 deg.
74 deg. – 68 deg. = 6 deg.
70 deg. – 6 deg. = 64 deg. = normal for this tape.
For new graph:–
Trace net, make intersecting normals coincident, and trace curve.

THE graph above reproduced has been submitted by H. D. Hurley, assistant engineer, Massachusetts Department of Public Works. Its use is self-explanatory.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Testing an Arch Dam

Sir—There is a general impression that a successful test to destruction of a large piece or member aids in developing a formula that will be safe when applied to smaller units. But when tests on a small specimen are made, more risk is involved if the developed expression is applied to large constructions.

On p. 816 of your May 14 issue there is a discussion of a proposed experimental arch dam. As it is of the curved type the radius becomes an important factor. Much is now known about thrust in masonry bridges and retaining walls of moderate radius, 100 to 300 feet. Would there be an advantage in an increase of radius of the proposed dam? Could not dams of less radius be as readily designed after the test, and dams of larger radius studied more successfully, if a radius of 400 or 500 ft. were adopted for the test structure?

A perfect location seems to have been selected. Doubtless a cableway will be used in construction. The cost per yard of a downstream short-radius dam built at the same time would be small. The quantity of water required for testing would be reduced, and also the risk below in the event of testing to destruction.

H. F. DUNHAM,
May 19, 1925. Consulting Engineer.

More Engineering By Questionnaire

Sir—Following is evidence of another instance of engineering by questionnaire as discussed by Professor McIntyre in your issue of May 14, 1925, p. 825. The professor observes that "few really competent highway engineers would reply to such a questionnaire," but is not the proper reply obvious?

There is a story of an eminent physician and professor of Edinburgh in the last century who was regaled with a careful description of disorders and symptoms by a brother Scot placed next to him at dinner who finally asked: "Doctor, what would you advise in such a case?" "I would advise you to consult a physician," the eminent one replied.

Advice to "consult an engineer" would seem not only the proper professional but also the most helpful reply that could be made to an engineering questionnaire.

Utica, N. Y., ARTHUR O'BRIEN,
May 22, 1925. County Superintendent of Highways.

[The following clipping is from the Hattiesburg, Miss., *American*, March 21, 1925:

. . . Mr. Boykin said that the [Highway] Commission had gone very thoroughly into the whole matter, as it had been appointed to do so by the board. It had endeavored to be fair and careful in every detail; that the members knew very little about paving before beginning their work, and realized the great responsibility devolving upon them; that their only object was to properly represent the Board [of Supervisors] and the people.

He further stated that he believed the people generally knew little about paving except the types here, and that the average person had never given the matter any study. He said that the commission had begun by first getting up the specifications, and then asked for bids on the four major types of paving that they proposed to consider; namely, brick, concrete, sheet asphalt and Warrenite-bitulithic, as these four complied with the requirements of the federal highway department, and that for its own satisfaction the commission had added one other type.

Commissioner Boykin said that the commission had investigated the various types, and had communicated with the highway departments of each state, and with city engineers in cities of over 100,000, for information; that a questionnaire had been sent asking information concerning the four types in consideration; that answers had been received from about 50 in many cities where paving had been done, valued in the millions, with much heavier traffic than here, and that a large majority showed that they were using and building Warrenite-bitulithic, even in the city streets where the traffic was unusually heavy. . . .

He stated that the specifications called for the entire program, but that they had divided it into "A" and "B," the "A" project to be on the streets where there was to be no federal aid, and "B" where federal aid was to be had; that this contract covered streets for which federal aid could be secured; that there was a difference between the streets and roads. He said the commission had unanimously concluded that Warrenite-bitulithic was both adequate and the most favorable bid received; that the commission felt that a type of pavement good for the big cities was good for Hattiesburg."—EDITOR.]

Control of Pedestrian Traffic

Sir—In connection with the system described in your issue of May 7, p. 761, used in the control of pedestrian traffic in Los Angeles, I would like to call attention to the fact that a similar system has been in use in Houston since July 1, 1924. The signals are of the "color light" type, changes being announced by a bell and by a small amber light below the signal lights. The traffic regulations are identical with those described.

The Houston signal system is in service on four parallel streets for a distance of nine blocks, and for a distance of four blocks on a fifth street. The signals are operated simultaneously from a centrally located control station.

Houston, Texas, A. W. BUNSEN,
May 16, 1925.

Road Grading Specifications

Sir—In respect to the editorial in *Engineering News-Record* of April 2, 1925, p. 547, "Road Grading Specifications," it seems that the following practice of the Greenwich Highway Commission may be of some value to engineers responsible for highway improvement, particularly those designing in a rolling country with considerable ledge rock.

Excavation is unclassified and is computed on the basis of old and finished sections. Slopes of finished sections are determined as nearly as may be by a careful study on the ground. The specifications give total excavation and amount of stripping under fills; in addition there is shown either on the profile or by tabulated sheets the amount of excavation and fill between stations.

An experienced contractor with the above data can readily estimate the percentages of rock excavation in the various sections. The closeness of his estimate depends on experience and knowledge of the terrain, but inaccuracies are somewhat balanced since flatter slopes in earth excavation give a greater quantity to offset a smaller but more costly rock excavation.

It has been my experience that one of the most troublesome problems for the bidder on unclassified excavation is estimating the amount of shallow rock excavation 6 to 18 in. in depth so often encountered when improving an old location. To meet this problem and also to protect the legitimate bidder, we have introduced an item called "subgrade rock excavation." This is measured on the square yard basis and covers an area 4 ft. wider than the pavement. The specification calls for removal of all rock to a depth of 18 in. below the finished surface of the pavement when the concrete is 7½ in. thick. This item is quickly and easily measured by the inspector; a survey party is not required.

I do not believe there is as much gamble in the item of unclassified excavation, particularly with the addition of the item subgrade rock, as is generally supposed. I have noticed that the percentage variation in bids is generally lower for unclassified excavation than for the pavement.

Experienced contractors who have worked under our specifications as outlined above are well satisfied; they can estimate percentage of rock closely enough; they lose no time waiting for a survey party to cross-section rock surface; they are protected against shallow rock excavation.

Greenwich, Conn., J. W. CONE,
May 23, 1925. S. E. Minor & Co.,
Civil Engineers.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

D. B. Steinman Elected A.A.E. President

American Association of Engineers Elects New York Engineer by Acclamation

David B. Steinman was elected president of the American Association of Engineers at its annual convention at Orlando, Fla., June 2-5, 1925. Dr. Steinman was born in New York June 11, 1886, graduated from the College of the City of New York in 1906 and received his degree in civil engineering at Columbia University in 1909 and his Ph.D. in engineering, from Columbia in 1911. From 1909 until 1911 he was first with the New York Public Service Commission and then inspector on the construction of the Catskill aqueduct. From 1910 until 1914 he was successively instructor, associate professor, and professor of civil engineering at the university of Idaho, and in general engineering practice. Following this he was associated with Gustav Lindenthal for 3 years on the design of the Hell Gate arch bridge and other bridges, and then for a year with J. A. L. Waddell on bridge design. From 1918 to 1920, Dr. Steinman was professor in charge of civil and mechanical engineering at the College of the City of New York. Since 1920 he has been in private practice (alone and associated with H. D. Robinson) specializing in bridge engineering. At present he is designing engineer for the Carquinez Strait cantilever bridge in California. Dr. Steinman was awarded the Croes Medal in 1920 for his paper entitled "Stress Measurements on Hell Gate Arch Bridge," and the Norman medal in 1924 for his paper on "Locomotive Loadings for Railway Bridges."

Conferences of Highway Traffic Committees Under Way

In preparation for the second national conference on street and highway safety which is to be held in Washington next December, a number of the committees have been meeting during the past few weeks to formulate their plans for reports. Committees on metropolitan traffic, uniformity of laws, regulation enforcement and causes of accidents have been formed. It is thought that the second conference will devote more attention to traffic regulation and control than to the safety side of the question, which was uppermost in the meeting last December, although it is obvious that the two are closely connected.

Engineering Fifty Years Ago

From *Engineering News*, June, 1875

PERHAPS the heaviest piece of main line traffic in the world is that on the London and North Western Railway between London (Euston Station) and Rugby — a section 83 miles long. On this section the following trains run through: 30 express trains at 40 miles an hour; 5 at 36 miles an hour; 29 passenger trains at lower speeds and stopping at all stations; 32 express goods trains at 20 to 25 miles an hour; 27 ordinary goods trains, and 23 local goods and mineral trains — a total of 64 passenger and 82 freight trains in 24 hours.

World Trade Problems To Be Discussed

The International Chamber of Commerce will hold its Third Congress in Brussels, Belgium, June 21-27, 1925. Economic restoration will be the keynote of the meeting, which has to do principally with the problems arising out of the adoption of the Dawes Plan and the alarm which manufacturers in many countries have expressed over the fear of an inundation of manufactured goods from Germany in the discharge of her reparations obligations.

The remaining subjects of the congress are of a more technical nature. They are divided into three classes: Finance, industry and trade, and transportation. The finance session will take up the problem of double taxation, or taxation of the same enterprise by two or more countries.

Unfair competition, particularly as it is expressed through piracy of trade marks, fraudulent use of patents, and similar trades abuses, will be a leading subject of one meeting.

Transportation will occupy another session. Competition between the motor car and the railroad, and the relation between the two, will be one aspect of the problem. Commercial aviation is essentially an international problem since the airplane in its use often passes over several frontiers. The standing committee on commercial aviation will study the progressive development of commercial aviation at the meeting.

The International Chamber of Commerce was created in June, 1920, and embraces representative organizations of industry, trade and banking in the principal countries of the world. It is a clearing house for information about international trade and trade practices. In its roster are found 329 Chambers of Commerce and 50 trade associations.

Mansfield Merriman, Pioneer Educator, Dies

Head of Civil Engineering Department at Lehigh University for Many Years

Mansfield Merriman, for many years professor of civil engineering at Lehigh University and author of many standard textbooks on civil engineering, died on June 7 at his home in New York City in his 78th year. Since his retirement from professional work in 1907 he had resided in New York, where he was engaged in consulting work and with his activities as editor-in-chief of the American Civil Engineers Pocket Book.

He was born in Southington, Conn., March 27, 1848, and was graduated from Yale in 1871. After a short period with the U. S. Corps of Engineers he went to Germany to take a course in the technical schools there, returning to Sheffield Scientific School at Yale as instructor in 1874. In 1878 he became professor of civil engineering at Lehigh, remaining there until 1907.

Professor Merriman was engaged as consulting engineer on many hydraulic and bridge problems, notably as a member of the Manhattan Bridge Commission in 1903, but he early in life devoted himself to engineering literature and gave to this field most of the time spared from college duties. The following bibliography of his books and writings is testimony to the amount and extent of his literary work:

Theory and Calculation of Continuous Bridges. 1876.

Elements of the Method of Least Squares. 1877.

The Figure of the Earth. An Introduction to Geodesy. 1881.

Method of Least Squares. 1884. (8th Edition 1904.)

Mechanics of Materials. 1885. (10th Edition 1905.)

Treatise on Hydraulics. 1889. (10th Edition 1916.)

Roofs and Bridges (4 volumes) with H. S. Jacoby. 1890. (Part I, 6th Edition; Part II, 3rd Edition; Part III, 5th Edition; Part IV, 3rd Edition.)

An Introduction to Geodetic Surveying. 1892.

Strength of Materials. 1897. (6th Edition 1907.)

Elements of Sanitary Engineering. 1898 (3rd Edition 1907.)

Elements of Precise Surveying and Geodesy. 1899. (2nd Edition.)

Elements of Mechanics. 1905.

Handbook for Surveyors, with John P. Brooks. (4th Edition.)

(Continued on p. 996)

Electrification on New York Central Approved

The New York State Public Service Commission has issued an order approving the plans of the New York Central R.R. Co. for the electrification of the Yonkers branch of its Putnam division. The order provides that the existing system of electrification on the New York Central in New York City shall be applied, the system being the under-running contact type of third rail having a nominal voltage of 650 volts, direct current. The company proposes to proceed immediately with the electrification of the two tracks of the branch, including the sidings and cross-overs. Plans and specifications for the proposed work must be submitted to the commission for approval before any construction work is done. The order also directs the railroad to file on or before July 1, 1925, a statement or detailed plans for the electrification of its so-called main line, Putnam division, and Saw Mill River branch, north of the Yonkers branch.

In his opinion Chairman William A. Prendergast, who heard the arguments in the case says:

"Request by the company is made, in so far as the main line of the Putnam division is concerned, that the electrification be held in abeyance pending the development of some satisfactory type of Deisel-electric engine, as the expenditure required for this work would necessitate the outlay of millions of dollars with no substantial improvement in transportation effectiveness if the electric locomotive or the multiple unit car taking propulsion current from the third rail were used, and that in addition there would be the practical certainty of substantially increasing the present deficit of operation over this part of the company's system. The engineering department of the New York Central R.R. Co., subsequent to the hearing, have been carrying on investigations of the Diesel-electric engine as a substitute for the third rail system of electrification and operation, and within the past week have invited proposals from 3 different manufacturers for freight and passenger engines of the Diesel-electric type, believing that this type of motive power will satisfy the requirements of the law and provide an efficient and economical type of engine."

St. Lawrence River Studies

A study of the ice situation on the St. Lawrence is to be one of the early activities of the Joint Engineering Board. It is believed that certain channel alterations can be made which will prevent some of the trouble which now has its rise in that source.

Another of the early activities of the Board will be the determination of the character of the material which will be encountered at the points where channel enlargement is contemplated.

Calculations will be made of flowage damages. Topographic surveys will be necessary at points where excavations or fills are contemplated. Borings will be made on the proposed sites of all the principal structures.

Bureau of Mines Transferred to Department of Commerce

As part of the plan for consolidating the business agencies of the government in the Department of Commerce, the President, on June 4, issued an executive order transferring the Bureau of Mines from the Department of the Interior to the Department of Commerce. The officers of the Bureau of Mines having to do with the leasing of coal, oil and other mineral lands will remain in the Department of the Interior. In discussing the transfer of the Bureau to his department, Secretary Hoover said that he soon would appoint a committee including representatives from the American Mining Congress of the American Institute of Mining & Metallurgical Engineers to study ways and means of increasing the efficiency of the Bureau of Mines.

The Secretary of the Interior, in announcing his approval of the change, said that it was made to eliminate much duplication of work in the two departments in research along lines of interest to both departments.

Chicago Sanitary District Can Now Dredge Calumet

By permit issued May 18 by the War Department, the Sanitary District of Chicago may dredge the Calumet and Little Calumet Rivers for eight miles between Lake Calumet and the Sag Channel, the later constructed at a cost of $14,000,000. The improvement is estimated to cost $1,500,000 and involves deepening the channel 13 or 14 ft. and widening it on the bottom to 90 ft. It is the last link permitting the 2,000 sec.-ft. flow, for which the Sag Channel was designed, to be discharged into the Chicago Drainage canal during floods and a diversion of this amount from Lake Michigan at low water stages in the Calumet. It is one of the improvements recommended by the Engineering Board of Review. The improved rivers will provide a suitable connection between Lake Michigan and the Calumet-Sag Channel and tend to prevent the pollution of the Dunne and Sixty Eighth St. water intakes now frequently endangered. Since the Calumet River discharges into Lake Michigan many times per year, the typhoid epidemic of November 1923 was charged to this pollution. (See *Engineering News-Record*, Jan 18, 1924, p. 116.) The permit does not allow more water to be taken from Lake Michigan than that granted in the 8,500-sec.-ft. permit of March 3, 1925.

Water Power Tunnel in Scotland

In the report of the letting of a contract for a 15-mile rock tunnel for a hydro-electric project in Scotland in *Engineering News-Record*, April 23, 1925, p. 705, it was stated that Balfour, Beatty & Co., of Edinburgh, Scotland, were engineers for this piece of construction. This statement was in error. Balfour, Beatty & Co. are the contractors for the work. The engineers are C. S. Meik & Buchanan, Westminster, London, England.

Dr. Travis, Contributor to Science of Sewage Treatment, Dead

Dr. William Owen Travis, whose studies of sewage treatment led to the introduction at a few places in England some twenty years ago of the two-story sewage-settling and digesting tank bearing his name, died at Hampton, England, on May 4, at the age of 68 years.

Dr. Travis was a doctor of medicine by education who lived with relatives at an old manor house near the Hampton sewage-works. Having an abundance of time at his disposal, he became deeply interested in sewage treatment, and particularly in the work done at the Lawrence Experiment station of the Massachusetts State Board of Health. Family connections with Isaac Shone, inventor of the Shone sewage ejector, and with a Mr. Hughes, whose firm made the ejector and other pumping machinery as well, and intimacy with Lieut.-Col. Jones, V.C., a British engineer for many years in charge of sewage farms at British army stations in England, all combined to spur on Dr. Travis' interest in sewage treatment, besides affording him unusual opportunities for obtaining practical advice.

On a June day 21 years ago the writer of this notice visited Dr. Travis, his experimental tank and a full-size tank then nearing completion, the latter as a part of an enlargement of the Hampton sewage-works. The experimental tank was a large-sized glass model set up within the sewage pumping station and operated for test purposes in charge of a resident chemist—all at the expense of Dr. Travis. Never in all the writer's varied experience of 35 years with sewage-treatment enthusiasts has he met one more enthusiastic or better versed in the latest ideas on the subject. The writer was deeply impressed with Dr. Travis' intimate knowledge of the experiments of the Massachusetts Board of Health.

Although the Travis tank, as such, was built at but few places on a working scale, it was the practical forerunner of the two-story tanks which have come into wide use outside of Great Britain.

Dr. Travis did more than blaze the way for the two-story tank. He was a leader in recognizing the consideration that should be given to colloidal substances in sewage, as embodied in his "Hampton doctrine." In collaboration with Lieut.-Col. Jones he expounded this "doctrine" in a long paper on "Elimination of Suspended Solids from Sewage" which, with the discussion it elicited from all over the world, was a notable addition to the literature of sewage treatment. (*Proceedings*, Inst. C.E., Vol. CLXIV, 1906.)

Dr. Travis was a fine and lovable English gentleman of the late Victorian period, who devoted himself for many years to a hobby in applied sanitary science. His contribution to the art of sewage treatment should not be forgotten. Had he been an engineer by training and practice, or if he had had more of the common British commercial instinct than he possessed, a plea that he be not forgotten or generally overlooked might be unnecessary.

George H. Benzenberg Dies in Milwaukee

Prominent in Sanitary Work for Nearly Half a Century—Designer of Many Notable Projects

George H. Benzenberg, a city engineer of Milwaukee for 25 years, a water-works builder of national fame and a past president of the American Society of Civil Engineers died at his home in Milwaukee, Wis., on his 78th birthday, May 31, 1925. He had been long ailing and for several years had undertaken no professional engagements so that his end held little of surprise for his friends. They, too, were as many among the business men and great industrialists of his home city as among his brother engineers. Indeed in his command of friends outside of his profession and in the confidence in his common sense and integrity of these business and financial comrades, lay the dead man's power as an engineer and city developer. Without this strength he could not have put through the engineering plans that made him professionally famous for many of these plans were bitterly opposed and not the least by men of his own brotherhood. His engineering was a catholic fellowship with business and industry and not narrow professionalism.

George H. Benzenberg was born in New York City in 1847. The following year his parents moved to Detroit, Mich. There the boy got his preliminary schooling and in 1863 he entered the University of Michigan at Ann Arbor where then Prof. DeValson Wood was instructor. Finding work during vacations with the U. S. Lake Survey the young Benzenberg naturally turned to that organization for his first job after graduation. In 1869 he changed to railway engineering as a more promising field. Then the financial crash of 1873 put an end to railway building. The next spring offered a position as assistant city engineer in Milwaukee and then began a service to one community which was unbroken for a quarter of a century. In 1882 on the death of Moses Lane, Benzenberg rose from an assistant to city engineer and this was the last change until 1899 when the office was resigned. As consulting engineer he completed the first Cleveland water tunnel and the Cincinnati water supply system and did much advising on smaller operations. Almost his last professional work and his last official service for Milwaukee was as a member of the Sewerage Commission which is about completing one of the greatest disposal works of modern times, a culmination of the sanitary works begun by him almost a half century ago.

Benzenberg's advent in city engineering was at a time when the large lake cities were just taking on metropolitan characteristics in their requirements for sanitation, water supply and street improvements. It was an opportunity to which the new city employee rose ambitiously. Indeed his ambitions for city development constantly outran the sense of the public for its need. His projects one after another as they were announced were first scoffed at and then combated. An instance was his plan to purify the Milwaukee River which traversed and was the harbor of the city. The stream was fetid with sewage and factory wastes, business was moving from its vicinity and with this movement shipping was falling off. Remedy was vital.

City engineer Benzenberg offered a plan for flushing the river. It was to build a 12-ft. tunnel from the lake to a point above the mouth of the river and through this tunnel with a screw pump 13 ft. in diameter to force water to flush the river. Almost at once the plan was denounced as impracticable and extravagant. A commission of engineers engaged to review the plans declined to approve them. The city engineer refused to give up his project and rallied every force to win the city councils to his plan. Here his standing in the confidence of strong business men helped him to win. The tunnel and pump were put in operation in the fall of 1888. In 24 hours the nuisance was abated and in a week the river was clean. So it was that Benzenberg fought for intercepting sewers, street viaducts, steel bascule bridges and for the first triple-expansion pumping engines to be installed for city water-works.

The further schedule of Benzenberg's engineering accomplishments can be found in the records of the technical societies of which he was an honored member. They, however, were not his monument. This was that he elevated the engineering department of the city in which he lived and worked, into a virtual independence of political exigencies and into the consciousness of the commercial and industrial public. In the period before 1890 this was an unusual condition. It was for this accomplishment as much as for his engineering skill that George H. Benzenberg in later years received honors from his profession. He was elected President of the American Society of Civil Engineers for 1907 and in 1911 he was given the degree of Doctor of Science by the University of Wisconsin. He also held high honors in the masonic lodges.

D. & H. Co. Loses Its Automatic Train-Control Case

The application of the Delaware & Hudson Co. for an injunction to set aside the order of the Interstate Commerce Commission requiring it and other railroads to install automatic train control devices was denied, recently, by a statutory court of federal judges. The case was a test case brought by the Delaware & Hudson Co., but affecting most of the major railroad systems of the country. The court, however, granted the company an injunction against being prosecuted and against any effort to enforce penalties for failure to install the automatic train control devices on the section of its road specified by the Commerce Commission before July 18, 1926.

Western Society Closes Year with Annual Meeting

Presentation of the Washington award and three Chanute medals, a review of the past year's achievements by E. T. Howson, retiring president, and an address by Judge J. H. Wilkerson on the duty of the professional man as a citizen comprised the program June 3 of the annual meeting of the Western Society of Engineers. Despite the heat 160 members attended.

The society now numbers 2,478, making a net gain for the year of 144. The board has cleared out the delinquent list, less than 5 per cent being in arrears at present.

During the year thirty-eight technical meetings were attended by 6,717 persons, exceeding by 30 the high mark of 5 years ago.

The library of 9,000 volumes had an addition of 600 books. A new cataloguing, now 80 per cent done, will be completed in November. About $5,000 or 12 per cent of funds of the society have been spent on the library. This seemed large to Mr. Howson and for more effective service and use he suggested that steps be taken to merge with it certain commercial engineering libraries, the companies making a contribution to the society for upkeep and service.

Announcement was made of an addition of $2,000 for the Washington award fund to the society by John W. Alvord. This award was presented this year to J. Waldo Smith as noted in last week's issue. Chanute medals for best papers were presented as follows: Paul L. Battey on "Mechanical Equipment of a Railroad"; Walter A. Shaw on "Shall Public Service Be Rendered by Regulated Monopolies" and the late John F. Hayford on "Establishment of Isostasy."

H. Foster Bain, Director of Bureau of Mines, Resigns

H. Foster Bain, director of the U. S. Bureau of Mines, has resigned to become secretary of the American Instiutte of Mining and Metallurgical Engineers. Mr. Bain is a graduate of Johns Hopkins University and the University of Chicago. His early work was with the Geological Surveys of Iowa and Illinois and with the U. S. Geological Survey. He served in an editorial capacity with *Mining and Scientific Press* and the *Mining Magazine* of London. During the war he served as assistant director of the Bureau of Mines and in 1921 was made director.

Trenton Sewage-Works Contract Set at $992,683

The contract for the 30-m.g.d. sewage-works at Trenton, N. J., has been let for $992,683, or 91.5 per cent of the engineer's estimate. It went to the J. P. White Co., Passaic, N. J., the lowest of the four bidders cited in our issue of April 23, p. 705. George A. Johnson and George L. Watson, New York City, are consulting engineers and Alfred C. Gregory is engineer of sewers.

Mansfield Merriman, Pioneer Educator, Dies

(*Continued from p. 993*)

Mathematical Monographs (11 volumes) (4th dition). Edited with R. S. Woodward Editor in Chief, American Civil Engineers' Pocket Book (1st Edition 1911, (2nd Edition 1912.)

He was also Associate Editor for Appleton's Universal Cyclopedia, as well as for Johnson's Universal Cyclopedia 1894-1896.

From among his many contributed writings the following few are mentioned:

Graphic Solution of Cubic Equations, *Transactions*, Engineers' Club of Philadelphia. 1884.

On the Equation of the L. U. Curve, *Journal* of Engineering Society of Lehigh University. 1887.

On the Theories of the Lateral Pressure of Sand against Retaining Walls, School of Mines *Quarterly*. 1888.

The Contact between Wheel and Rail, *Railroad Gazette*. 1889.

On the Stresses Produced by Suddenly Applied Forces and Shocks, *Railroad and Engineering Journal*. 1889.

The Determination by the Method of Least Squares of the Relation between Two Variables connected by the Equation $y = ax + b$, Both Variables being Liable to Errors of Observation, *Report*, U. S. Coast & Geodetic Survey. 1890.

Final Formulas for the Algebraic Solution of Quartic Equations, *Bulletin*, New York Mathematical Society. 1892.

The Strength and Weathering Qualities of Roofing Slate, *Transactions*, American Society of Civil Engineers. 1892.

Influence of the Moon on Rainfall, *Science*, 1892.

Training of Students in Technical Literary Work, *Proceedings*, Society for Promotion of Engineering Education, 1893.

The Rational Design of Columns, *Engineering News*, 1894.

The Resistance of Materials under Impact, Vice-Presidential Address, Section D, American Association for Advancement of Science, 1894.

Teachers and Text-Books in Mathematics for Technical Schools, *Transactions*, Society for Promotion of Engineering Education, 1894.

Deflection of a Rail under Impact, *Railroad Gazette*, 1895.

Past and Present Tendencies in Engineering Education, Presidential Address, 1896, Society for Promotion of Engineering Education.

The Probability of Hit when the Probable Error in Aim is Known; With a Comparison of the Probabilities of Hit by the Methods of Independent and Parallel Fire from Mortar Batteries, *Journal*, United States Artillery, 1897.

Entrance Requirements of Engineering Colleges, *Engineering Record*, 1897.

The Work of International Association for Testing Materials, *Bulletin* of American Section, 1899.

The Principle of Least Work in Mechanics and Its Use in Investigations regarding the Ether and Space, American Philosophical Society, 1902.

Relation between the Economic Depth of a Bridge Truss and the Depth Which Gives Greatest Stiffness, American Philosophical Society, 1905.

The Cattle Problem of Archimedes, Popular Science Monthly, 1905.

It was said of Professor Merriman that from his boyhood days he always had an insatiable appetite for learning and study. As a very young boy he could read Latin almost as fluently as English. He also knew much Greek and later on acquired both French and German. He always would rather study than do the chores, as did the others of the family, and ofttimes he was reproached for attempting to milk a cow with one hand while with the other he was holding a volume of Caesar's "Commentaries."

His father, not believing in the heresies of higher education, was very much opposed to the thoughts which he entertained of attending college at Yale, and so, in order to accomplish his purpose, it was necessary for him to run away from home, which he did, and went to New Haven, passing the Sheffield entrance examinations in about 1867. Both during his student days and later, while an instructor at Sheffield, he collected a very extensive herbarium of the flora of Connecticut and knew intimately the geology of the country for many miles in every direction, in consequence of many long walks and tramps over many parts of the state.

In order to facilitate his collegiate work he acquired shorthand for taking notes and for reporting events in his diaries, as to which he was always very methodical. Unfortunately these diaries are nearly all written in shorthand.

While working his way through Sheffield, among other jobs he spent considerable time in a printer's office, setting up type, and so he was familiar with the printer's art, which always found expression in the typography of the books which he later came to write.

Professor Merriman received many academic honors. From Yale he had the following degrees; Ph.B. (1871), C.E. (1872), Ph.D. (1876) and he was awarded the honorary degree of Sc.D. from Pennsylvania in 1907 and LL.D. from Lehigh in 1913. He was a founder and past president of both the American Society for Testing Materials and the Society for the Promotion of Engineering Education and a member of the American Society of Civil Engineers.

A Summer Session in Industrial Organization and Management

The tenth annual summer course in industrial organization and management at the Pennsylvania State College will be held June 22 to July 3, 1925. The subjects covered will be: The principles of organization and administration; the industrial plant, location, layout and maintenance; the fundamentals of purchasing; the fundamentals of interchangeable manufacturing; the place of time study in modern industry; and the fundamentals of industrial costs.

Random Lines

The Worshipful Company of Paviors.

Among the numerous old Guilds of the City of London is The Worshipful Company of Paviors. This guild, states London *Municipal Engineering* of May 21 in a one-column-plus account of a "ladies banquet" recently given by the six-century-old institution, can trace its "history back to the year 1302, when four paviors, whose names are still preserved, were sworn to make the pavement throughout the streets and places of the City in the manner most commodious for the public and according to the ordinance of old approved." In return for powers and privileges conferred on the guild by the Court of Aldermen of the City, the guild was "held responsible," says the journal mentioned, "for the provision of skilful workmen and journeymen." After 1845, the paviors company fell into innocuous desuetude. It resumed activities in 1889, though apparently confined them to banquets, prize essay competitions and the like. Recently the guild has been promoting the establishment of a "Chair of Highway Engineering at the London University," toward which 7,000 guineas have been subscribed.

* * *

Putting It Up to the Wife

According to the National Industrial Conference Board the interest of employing industries in the necessity for the employee taking a vacation is rapidly growing, one company for instance sends, a few days before the vacation begins, the following notice to the employee's wife:

"We have given Mr. Smith a 10-day vacation with pay. While we appreciate that this time is his to do with as he pleases, we hope you will not insist that he spend all of it in cleaning out the cellar, the hen-coop, and so on. We feel that it is to his benefit, to yours and to ours that he spend as much time as possible in the fresh air and, with this in mind, we are sending this outdoor cooking outfit and we hope that Mr. Smith will take the family to frequent picnics and make the most of it."

* * *

Proof By Test

A speed-boat the other day beat the New York Central Railroad's fast train, the Twentieth Century in a "race" from Albany to New York, this proving beyond all possible chance of a doubt that a vehicle making 55 miles an hour can go faster than one making 45 miles.

* * *

Field Parties De Luxe

Four hundred government stenographers, the Denver *Times* makes an A. P. dispatch say, are taking the field this month to resume annual work on the $50,000,000 map of the United States.

Engineering Societies

Calendar

Annual Meetings

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, University of Pittsburgh; Annual Meeting, Union College, Schenectady, N. Y., June 17-20, 1925.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, Atlantic City, N. J., June 22-26, 1925.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Summer Meeting, Salt Lake City, July 8-10, 1925.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Petersburg, Fla.; Annual Meeting, Des Moines, Iowa, Oct. 26-29, 1925.

The Providence (R. I.) Engineering Society announces June 12 as the date of its annual smoker and as speaker Col. C. H. Birdseye, who made the well-known survey of the Colorado River, as chief engineer of the U. S. Geological Survey; the lecture will be illustrated with lantern slides and moving pictures of the work of the survey.

The New England Water Works Association announces a definite date of June 25 (tentatively given June 23 in our issue of May 28) for the excursion to which it has invited the Boston Society of Engineers, to the additions, now under construction, of the Providence, R. I., water-works.

Personal Notes

JOHN G. VALENTINO, who has been superintendent of the water-works at Savannah, Ga., has severed that connection and has become associated with the Union Water Meter Co. as its southern sales representative, with headquarters in Savannah.

JAMES BAIRD, formerly president of George A. Fuller Co., and THOMAS W. MCKNEW, also formerly of that company, announces the formation of the James Baird Co., builders, with offices in the Otis Building, Washington, D. C., and at 441 Lexington Ave., New York City.

MARVIN CHASE, state supervisor of hydraulics for Washington for a number of years, has resigned, and has been succeeded by R. K. TIFFANY of Spokane, Wash. Mr. Chase has been engaged in hydraulic and irrigation work for more than 35 years, and has recently been very active in the work of the Columbia Basin project. Mr. Tiffany has for three years been in charge of irrigation development in the Spokane Valley, and prior to that was manager of the Yakima Irrigation project.

CHARLES H. RANKIN, of Denver, has been appointed railway and hydraulic engineer for the Colorado Public Utilities Commission, filling the vacancy caused by the death of W. L. REYNOLDS.

GEORGE H. PARKER, engineer in charge of the Southern Maryland district of the Maryland State Roads Commission for four years, died May 30 at Baltimore, Md.

CARLETON E. DAVIS, who for the past two years has been manager of the Indianapolis Water Co., Indianapolis, Ind., is to return to Philadelphia, Pa., as manager of the Philadelphia Suburban Water Co. Mr. Davis was chief of the Bureau of Water of the city of Philadelphia from 1912 to 1923, when he went to the Indianapolis waterworks, and had previously been connected with many important waterworks construction projects.

HOWARD S. MORSE, at present business manager of the board of education, Akron, Ohio, has been made manager of the Indianapolis Water Co., succeeding CARLETON E. DAVIS, who goes to the Philadelphia Suburban Water Co.'s service. After considerable earlier engineering work, Mr. Morse was on sewerage construction at Louisville, Ky., 1908 to 1912, and principal assistant engineer in charge of sewerage for Cincinnati, Ohio, 1912 to 1914. He was then director of the Bureau of Municipal Research at Cincinnati, 1914 to 1916, and engineer of a similar bureau at Detroit, Mich., 1916 to 1917. Since 1918 he has been in Akron, first as director of public service, then as employment manager of the Goodyear Tire & Rubber Co., and recently as manager of the city board of education.

SAMUEL INSULL of Chicago has been elected president of the National Museum of Engineering and Industry for the coming year.

WYNKOOP KIERSTED, JR., has been appointed chief engineer and superintendent of the Water Department of Kansas City, Mo., to succeed CHARLES S. FOREMAN, resigned. For the past ten months Mr. Kiersted has been assistant engineer in the Water Department.

JOHN H. MULLEN has resigned as first assistant commissioner and chief highway engineer in the Minnesota State Highway Department and has become a member of a contracting firm in Minneapolis under the name of Nelson, Mullen & Nelson. He is succeeded by J. T. ELLISON, formerly second assistant commissioner.

HUGH W. FRITH, assistant chief engineer, Vancouver Harbor Commission, Vancouver, B. C., has been appointed chief engineer of the commission, the post recently vacated by Major W. G. SWAN, who has entered private consulting engineering practice in Vancouver. Mr. Frith was born in London, England, and received his education in Cape Town, South Africa, at the Technical Institute. After early engineering work in South Africa he returned to England and in 1912 went to Vancouver as assistant in the city engineer's department. In 1915 he was engaged on hydrographic survey of the Fraser River and Squamish, as assistant with the Public Works Department of Canada. The following year he joined the staff of the Vancouver Harbor Commission as assistant engineer, was promoted to maintenance engineer and then to assistant chief engineer in 1919.

C. A. BENNETT, valuation engineer of the Maryland Public Service Commission, has been appointed property appraisal engineer for the city of Baltimore, to work under the direction of the Commission on Efficiency and Economy. He will take up the work on June 16 and continue until the end of the year. Authority for the appointment of three junior engineers to work with Mr. Bennett also has been granted.

EDWIN E. MILLER has been appointed deputy commissioner of public works at Rochester, N. Y., succeeding Armour S. Lloyd, who has retired after thirty years' service. Mr. Miller, after education at the University of Rochester, became identified with the department of public works in 1907 as an inspector of trenches and sewers and has since worked his way up to the present appointment.

UEL STEPHENS, San Antonio, Texas, has severed his connection with the firm of The Terrell Bartlett Engineers, Inc., of San Antonio, and has accepted a position as district engineer for the Clay Products Association serving, with headquarters in San Antonio, the territory of Texas, Louisiana, and southern Oklahoma and Arkansas.

BRIG. GEN. EDGAR JADWIN, assistant chief engineer of the Corps of Engineers, has received the degree of Doctor of Engineering from Lafayette College.

DR. A. A. POTTER, dean of the School of Engineering at Purdue University, and president of the Society for the Promotion of Engineering Education, received the degree of Doctor of Engineering from Kansas State Agricultural College on May 28.

Obituary

JOACHIM G. GIAVER, consulting structural engineer, Chicago, who died May 31, was born in Norway in 1856 and graduated at a college in that country in 1881. Coming to the United States, he was at first in the bridge department of the Northern Pacific Ry., 1882-1883, and then with the Shiffler Bridge Co. until 1890, being chief engineer for six years. He was assistant chief engineer of the Columbian Exposition at Chicago in 1891-1893, and then went into the contracting business until 1897, when he became an assistant engineer for the Sanitary District of Chicago. In 1898 he became chief engineer for D. H. Burnham & Co., architects, and designed the structural framing of several of the large office buildings of Chicago. This position he resigned a few years ago in order to take up private practice in partnership with F. P. Dinkelberg, under the firm name of Giaver & Dinkelberg.

From the Manufacturer's Point of View

A Point of Contact
Between Maker and User of
Construction Equipment and Materials

Diesel Engine Development

Use of Two-Cycle Solid Injection Type and Refinements in Design Make for Greater Dependability

By R. H. Bacon
Oil Engine Division,
Fairbanks, Morse & Co., Chicago

ONE of the reasons for the interest in the application of Diesel engines to a wide variety of power problems is the increased dependability of these prime movers brought about by recent mechanical improvements. The trend has been distinctly toward the development of two-cycle solid injection machines and it appears that the engine of the future will be of this type. A feature of the latest machines is the elimination of auxiliary ignition devices for starting, this operation now being accomplished by compressed air at 200 lb. per sq.in. stored in steel tanks.

In order to understand the reasons which lie back of the simplicity of the two-cycle solid injection Diesel engine, it is necessary to have some idea as to how this type operates. The cross-section of this engine (Fig. 1) indicates the absence of complicated parts. In the two-cycle engine there are no inlet or exhaust valves, as the piston performs their functions. On the down-stroke of the piston the air which has entered the crankcase through the air inlet screen is slightly compressed, and when the air inlet port is uncovered by the piston this scavenging air flows up through the passageway and clears the cylinder of the gases due to combustion. It will be noted that this passageway is outside of the water jacket thus eliminating the necessity for air ports in the pistons.

On the return stroke the piston covers both the air inlet and exhaust ports, and the charge of fresh air is compressed in the cylinder. As the piston approaches the top of the cylinder the injection of the fuel oil takes place through the nozzle into the auxiliary combustion chamber. The air which is being compressed rushes through the neck of this chamber and in meeting the spray of fuel from the nozzle breaks it up into a finely atomized state. In the meantime, the piston has been moving up and the compression pressure has reached about 500 lb. per sq.in. which raises the temperature of the charge to practically 1,000 deg. F. Ignition then begins and the burning gases expand through the neck of the auxiliary combustion chamber into the cylinder proper, where combustion is completed. The combustion does not cause any rise in pressure, above the 500 lb. per sq.in., and the expansion is, therefore, similar to that of steam.

Vibration in Diesel engines is largely a problem of proper balancing of the moving parts, since shocks are eliminated by the constant pressure combustion characteristics of the machine. The fuel does not explode, but burns. In one, two, and three-cylinder engines, the moving parts are balanced by counterweights. Crank arrangements secure the balance in the four and six-cylinder types. In stationary plant practice, where it is possible to provide a rigid foundation, vibration can be reduced to a minimum. For work requiring a certain portability, as in power shovel and excavation work, the suspension of the unit must be given consideration in any attempt to reduce vibration.

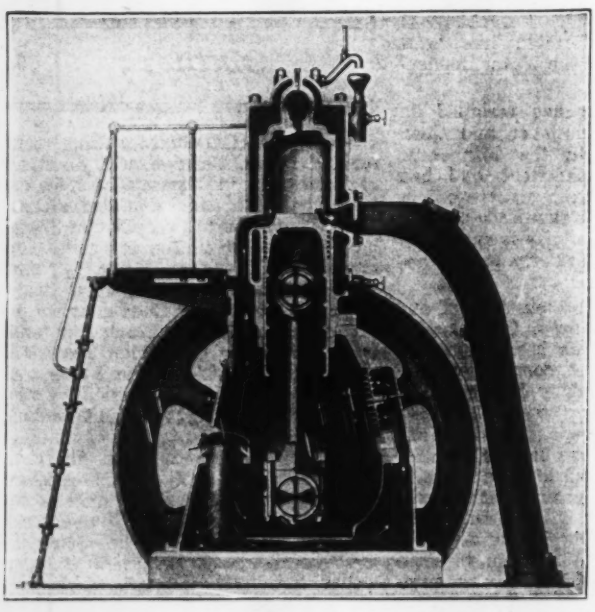


FIG. 1—CROSS-SECTION OF TWO-CYCLE DIESEL ENGINE

The fuel injection and governor unit is mounted at the end of the engine shown in Fig. 2. Each cylinder has a small injection pump, and the amount of fuel which is pumped to the cylinder is accurately controlled by the governor in accordance with the load on the engine. Starting is accomplished by compressed air, and no torch is necessary since the heat, due to the 500-lb. per sq.in. compression exerted by the piston fires the fuel. Lubrication is entirely automatic, the mechanical lubricator showing as the rectangular box at the end of the engine in Fig. 2. This lubricator not only oils every bearing surface, but also controls the amount of oil used, thus reducing a formerly common waste and making it possible for manufacturers to guarantee as much as 2,000 b.hp. per gallon of lubricating oil.

Efficient manufacturing methods have also contributed to improvements in the Diesel engine. As an example, crankshaft failure was formerly attributed to inherent characteristics of Diesel engine operation. Crankshaft manufacture has since proved to be a metallurgical problem that is now overcome by pouring the ingot into a special mold so that the metal runs in at the bottom and rises to the top. The top third of the ingot is then cropped off, and the remainder is worked into shape under a hydraulic press. This operation refines the metal through its entire cross-section as is not the case with the old drop-hammer methods.

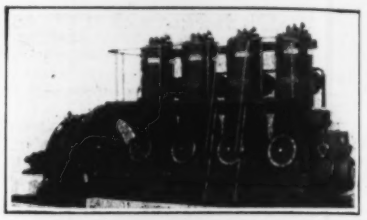


FIG. 2—200-HP. DIESEL ENGINE
Similar engines are built with any number of cylinders up to six, each additional cylinder adding 50 hp.

At the present time the improved Diesel engines are built in ratings of 37½ and 50 hp. for the single cylinder units; 75 and 100 hp. in two cylinders; 150 hp. in three cylinders; 200 hp. in four cylinders; and 300 hp. in six cylinders. Tests have shown a consumption of 0.42 lb. of 18,000 B.t.u. fuel oil per brake horsepower at full rated load. One of the characteristics of the engine is that the fuel consumption curve is practically a straight line on ratings varying from 75 to 120 per cent load.

Important Merger of Tractor Companies Is Announced

The Holt Manufacturing Company and the C. L. Best Tractor Co. on May 14 ceased operations under their respective names, and their plants and businesses passed to the Caterpillar Tractor Co., as announced in *Engineering News-Record*, May 28, 1925, p. 912. All assets of the Holt Manufacturing Co. and of the C. L. Best Tractor Co. were transferred to the Caterpillar Tractor Co., which assumed all liabilities of the two companies. Best and Holt tractors and parts for all models of the two tractors will continue to be manufactured by the Caterpillar Tractor Co. at its plants located in San Leandro and Stockton, Cal., and at Peoria, Ill.

These two companies furnish a large percentage of all tractors used in road

building, engineering and excavation in the United States. Each has contributed important equipment which has aided these operations. Aside from the large tractors, the Holt company and the C. L. Best Tractor Co. introduced many new ideas in snow removal, road building and excavation.

Following is the official statement concerning the merger:

The Caterpillar Tractor Co. was incorporated under California laws April 15, 1925. The stockholders of the Best and Holt companies have ratified the action of their respective boards of directors in exchanging the assets of the two companies for the stock of the Caterpillar Tractor Co. and the consummation of the consolidation was effected May 14, 1925.

The Caterpillar Tractor Co. will be guided by the following officers and directors: C. L. Best, chairman of the board; R. C. Force, president; B. C. Heacock, vice-president and secretary; M. M. Baker, vice-president; P. E. Holt, vice-president; O. L. Starr, general factory manager; Harry H. Fair; Allen L. Chickering; John A. McGregor.

Business Notes

WESTINGHOUSE ACCEPTANCE CORPORATION has been formed as a subsidiary to the Westinghouse Electric & Manufacturing Co., to furnish a more complete low-cost service to those providing the sales outlets of the parent company. These manufacturers and dealers will thus be assured of a more rapid turnover of their capital involved in time-payment transactions, and at the same time will be assisted in expanding their time-payment business. G. Brewer Griffin, recently manager of the Westinghouse automotive equipment department, will be vice-president and general manager with offices in East End Trust Bldg., Pittsburgh.

NUGENT STEEL CASTINGS CO., Chicago, manufacturer of small and thin section steel castings, has recently placed in operation an electric annealing furnace for the treatment of their entire product. The installation is unique, it is claimed, embodying features of design and of heat application, that have not hitherto been attempted in the heat treatment of steel castings.

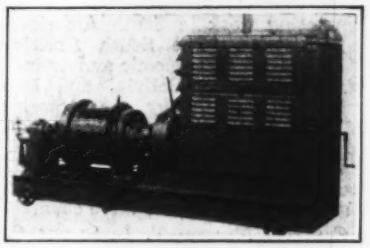
GRINNELL CO., INC., sales subsidiary corporation of the General Fire Extinguisher Co., Providence, R. I., has opened a branch in Minneapolis for the distribution of its products in the Northwest. The new Minneapolis branch will serve the heating and building trades of the Northwest. T. T. Cash, who has represented the Grinnell organization in this territory for several years, will be in charge of the branch.

G. R. LYMAN, formerly general sales manager of the Taylor-Wharton Iron & Steel Co., High Bridge, N. J., resigned, effective May 1, and G. R. Hanks, formerly superintendent of the High Bridge plant of the company has been appointed to take Mr. Lyman's place.

Equipment and Materials

Improved Motor for Construction and Industrial Use

The Waukesha Motor Co., Waukesha, Wis., has developed the Model CU intended for use principally on construction equipment such as power

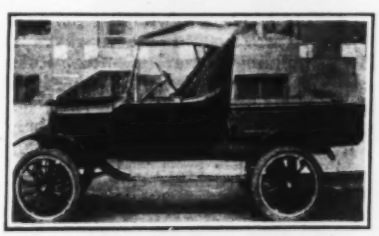


shovels, cranes, hoists, ditchers, compressors, pumps, etc. The motor has a bore of 5⅜ in. and stoke of 6¼ in. The power peaks at 1,500 r.p.m., at which speed it develops 70 hp. The maximum torque of 350 ft.-lb. is obtained at a speed between 500 and 700 r.p.m.

The motor can also be supplied in the form of a power unit to meet the many needs for portable power. This includes the motor mounted in a substantial frame and covered with a heavy sheet iron housing, radiator, gasoline tank, magneto, carburetor, vacuum tank, air cleaner, and power take-off with clutch. It is constructed so that it will give uninterrupted service in a driving rain.

New Ford Light Delivery Truck Has All-Steel Body

Ford Motor Co., Detroit, has recently placed a new light trucking unit on the market. The equipment is an adaptation from the standard Ford roadster with rear deck replaced with an all-steel pick-up body. Features of the body include side flanges, steel floor strips with sunken bolt heads, and rear



door adjustable chains. The inside dimensions of the body are 40¾ x 56 in. The height from the floor to the top of the flare is 13 in.

Superheat Steam Pipe Insulation

Last year the Philip Carey Co., Cincinnati, Ohio, made an interesting installation of superheat steam pipe insulation in the Fairmount pumping station, Cleveland, Ohio. The insulation used was the Carey Hi-Temp pipe covering, the first water-works installation of this superheat material.

The Fairmount station operates at about 300 lb. pressure and 150 deg. overheat, making a total temperature of approximately 550 deg. F. The problem on which heat insulation manufacturers have been working for a number of years is to get a combination of heat-resisting materials that would give reasonably good insulating value. Such insulation could then be used as a first layer next the superheated surface in combination with the better insulating materials such as 85 per cent magnesia, and in such thickness that the temperature on the inner surface of the 85 per cent magnesia or similar covering would be reduced to within the safe working temperature range of that insulation.

The Carey Hi-Temp pipe covering used in the Fairmount pumping station is 1 in. thick, and is covered with from 1 to 2 in. thickness of 85 per cent magnesia depending upon the size of the pipes involved. This Hi-Temp superheat insulation is a product developed through the research laboratories of the Mellon Institute, University of Pittsburgh. The heat transmission through it under the conditions involved is only about 8 per cent greater than through 85 per cent magnesia coverings.

Chlorine Is Applied to Open Swimming Pools

To meet the need for sterilizing bodies of water used for swimming purposes,

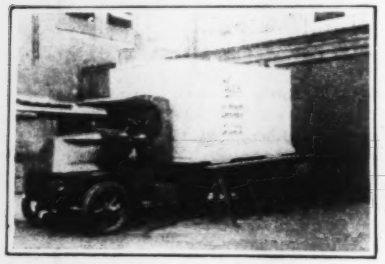
Wallace & Tiernan Co., Inc., Newark, N. J., developed the Chloro-boat. It consists of a vacuum type chlorinator mounted in a flat-bottom boat. Water is pumped through the chlorinator by a gasoline engine driven pump, the chlorine solution is formed, and is discharged from the rear of the boat. The velocity of this solution propels the boat slowly around the swimming area. It is claimed that 50 lb. of chlorine per day can be applied by this equipment from one cylinder of chlorine.

New Container for Freight Transport

The primary purpose of the new aluminum container manufactured by International Motor Co., New York, is to eliminate unnecessary handling of freight. The containers are 12 ft. 8 in. long, 8 ft. wide and 7 ft. high, and are made almost wholly of aluminum, the tare weight of each being 2,360 lb. One unit constitutes a load for a 7½-ton Mack truck and three units are a load for a 40-ft. flat car.

The ramp track method which is the main feature of the system is claimed to unload the containers much faster than can a crane. The ramp track is available in various forms ranging from the one-way back-in types for trucks to the large tracks equipped with transfer carriers capable of handling an entire train of flat cars in a very short time.

For the convenience of users who require a smaller unit, half-size containers are available. These smaller units will enter the door of a standard box car, and by means of a reversible wheel arrangement underneath the container, may be easily moved to either end of the car. None of the equip-

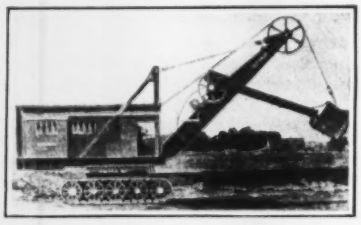


ment necessary for anchoring the containers on the trucks interferes in any way with the use of the truck for other purposes. The platform is floored and stake holes are provided to make possible conversion to a stake body on short notice.

New Heavy Duty Shovel

Designed especially for severe service such as is encountered in quarry and mine work, the new 4-yd. full revolving shovel, Model 120-B, recently put on the market by the Bucyrus Co., South Milwaukee, Wis., combines the rugged strength, power, and speed of a railroad type shovel with the greater mobility and full circle swing of a revolving shovel.

The base and revolving frame are of solid casting construction without structural work. The shafts are designed with from 30 to 50 per cent greater strength than heretofore used in conservative design. The grate area of the boiler is 10 per cent more and the heating surface 15 per cent greater than for the largest railroad type



shovel. Refinements on the new model consist of superheater equipment, a firebrick arch in the boiler, and brass shell bearings. It is claimed that this is the largest shovel that has yet been mounted on crawlers. This shovel is not intended for work where very wide digging and dumping reaches are required.

Publications from the Construction Industry

Rubber Goods—GOODYEAR TIRE & RUBBER CO., Akron, Ohio, has recently issued a new "Handbook of Mechanical Rubber Goods." The book contains information on the subject of power transmission by rubber belting, and explains the manufacture and uses of rubber hose and packing.

Concrete Construction — SOLVAY PROCESS CO. (Wing & Evans, Inc., Sales Dept., New York), tells in a 22-p. booklet how the addition of 1 to 4 per cent of calcium chloride strengthens concrete and accelerates its hardening, at the same time rendering it more waterproof, and aiding it to resist freezing temperatures.

South America—Of interest to engineers and contractors who are contemplating work in South America is a booklet on "The South American West Coast," an economic and financial survey of Chile, Bolivia, and Peru, published recently by the American Bankers Association. The booklet contains information on the geography, government, labor conditions, industries, transportation and financial history and condition of each of the three countries.

Concrete Mixers—T. L. SMITH CO., Milwaukee, has issued a 60-p. catalog describing its line of mixers and pavers. In addition, the catalog contains page illustrations of such works as the Wilson Dam at Muscle Shoals, Ohio State University Stadium, Exchequer Dam, and the General Motors Building, Detroit, upon all of which Smith mixers were used.

Cranes and Shovels—HARNISCHFEGER CORPORATION, Milwaukee, has recently issued a 64-p. book entitled "Forty Years of Progress" in which is given a history of the development of this organization. Pictures and short descriptions of each of the various products in the electric crane, hoist, machine tool, and gasoline excavator lines are also given.

Metal Lath — NORTHWESTERN EXPANDED METAL CO., Chicago, has issued a new catalog on expanded metal products to supersede its old "Fireproof Construction Book."

Cement Tile—FEDERAL CEMENT TILE CO., Chicago, has issued a booklet under the title of "Roof Standards." It contains, besides complete general roof tile specifications and specifications covering the various types of cement tile, 26-p. of detail drawings showing the application of precast reinforced-concrete slabs to all types of roof construction.

Traffic Signals — GRISWOLD SAFETY SIGNAL CO., Minneapolis, Minn., has published a 16-page booklet on the Griswold "American Bobby," a traffic signal device that can be set so as to operate automatically or can be operated by hand from the curb. A feature of the signal is that when struck by a vehicle it leans to the ground and bobs up erect again after the vehicle has passed over it.

Motor Trucks—AUTOCAR CO., Ardmore, Pa., in a new 60-p. catalog, describes, by means of text and illustrations, its line of 4 cyl. trucks. Special emphasis is placed upon the advantages of the short wheel base design dump truck for the coal trade, the building and general contracting field, and the road building industry.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Active Demand for Brick and Cement Points to Heavier Volume of Construction

With actual physical volume of construction (quantities of materials used) 8 per cent greater than at this time last year, a survey of mill and warehouse stocks shows all materials to be plentiful and shipments prompt.

A "hand-to-mouth" buying policy obviously prevails in all markets for basic building materials, necessitating the close adjustment of production to demand. Irregularity in buying, however, is shown by the fact that demand for brick and cement is increasing, while in lumber and steel the opposite condition exists.

These four basic materials are treated separately as follows:

Steel—While the May output of ingots was 3 per cent below that of April, it was also 30 per cent greater than in May, 1924. Total output for the first five months of 1925 was 9 per cent ahead of the corresponding period last year. The following figures show steel ingot production according to the American Iron and Steel Institute:

	1925 Tons	1924 Tons
January	4,198,564	3,649,913
February	3,756,243	3,826,246
March	4,198,520	4,206,699
April	3,587,524	3,348,466
May	3,458,253	2,640,034
5 months	19,199,104	17,671,358

Lumber — For the first twenty-two weeks of 1925, total production and shipments were below those of the corresponding period last year. Demand, however, was much heavier. The following table compares the national lumber movement, as reported by the National Lumber Manufacturers' Association, for the three weeks indicated:

	Week of May 30 Ft. B.M.	Corresponding Week in 1924 Ft. B.M.	Preceding Week in 1925 Ft. B.M.
Production	235,757,504	225,424,327	249,671,966
Shipments	248,299,451	206,423,684	251,963,808
New Business	222,058,262	177,647,933	243,671,190

The following figures compare the lumber movement for the first twenty-two weeks of 1925 with the same period last year:

	Production Ft. B.M.	Shipments Ft. B.M.	Orders Ft. B.M.
1925	5,277,903,270	5,221,954,235	5,070,985,895
1924	5,284,841,828	5,254,801,213	4,938,696,536
1925 Decrease	6,938,558	32,846,978	.....
1925 Increase	.....	.....	132,289,359

Brick—More brick (burned and unburned) are stacked at yards throughout the country and more are being moved from yards than at this time

(*Continued on p.* 1002)

Construction Shows Indications of Stabilizing Costs

Remarkable Agreement Between Trends of Number and Value of Projects in Last Twenty-Eight Months

A comparison of the money value of contracts let between Jan. 1, 1923, and May 1, 1925, with the actual number of awards in that period, reveals a striking similarity in trend and also what appears to be an evidence of stability in costs.

In only four instances during the period mentioned did the number of jobs increase or decrease without a corresponding gain or loss in the total money value. This is evidently due to the fact that during the twenty-eight months on only six occasions did the average value per contract each month go below $200,000 or above $284,000. Without stability of cost the average value per contract each month would have gone above or below the $228,892 maintained during that period.

With only slight fluctuations in cost occurring from month to month, increases or decreases in the number of projects at this fairly constant average cost per contract, resulted in the synchronous movement of the two curves as shown in the chart.

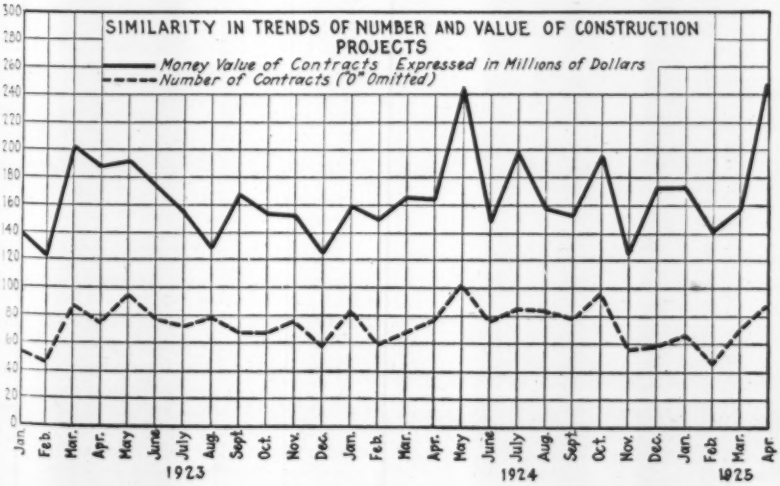
Had cost of labor and material shown a consistently downward trend, for instance, an increase in the number of projects in any given month might have been met by a drop in money value, thereby causing the two curves to diverge.

Similarly, a decided upward trend in cost might have given a drop in the number of jobs and a rise in the money value.

Cost stability is, therefore, the main cause of the similarity in trend of these two factors—money value and number of awards. The *E. N.-R.* Construction Cost Index Number for 1923 is 214.07 and for 1924, 215.36—a difference of only +0.6 per cent.

The average value per contract was $226,666 in 1923; $217,583 in 1924 and $269,500 for the first four months of 1925.

Construction News published 8,906 awards in 1923, 9,343 in 1924, and 2,712 between Jan. 1 and May 1, 1925.



The Manchurian Government proposes constructing the Mukden Rai Lung Ry. to extend 150 miles northeast from Mukden toward Kirin. Estimated requirements for this line include 18,000 tons of steel rails and accessories, 16 locomotives, and approximately 110 freight cars of different types, says Assistant Commercial Attache A. H. Evans, Peking, China, in a report to the Department of Commerce.

Proportion of Heating, Etc., to School General Contract

Figures Given for Seventeen Jobs in Eleven Cities from New York to Portland, Ore.

The accompanying figures give the cost relation between the general contract for schools and the contracts for heating and ventilating and for plumbing. The following figures were developed in connection with the compilation of building unit costs which *Engineering News-Record* is making, as announced in the issue of June 4:

City	General Contact	Heating and Ventilating	Plumbing
New York	$295,000	$44,000 (15%)	$89,000 (5%)
New York	369,000	48,000 (13%)	
New York	295,000	44,000 (15%)	
New York	837,000	113,000 (14%)	45,000 (5%)
New York	733,000	86,000 (12%)	42,000 (6%)
Philadelphia	1,766,000	206,000 (12%)	89,000 (5%)
Philadelphia	247,000	36,000 (15%)	
Philadelphia	834,000	78,000 (9%)	33,000 (4%)
Elizabeth, N. J.	429,000	83,000 (19%)	34,000 (8%)
Trenton, N. J.	369,000	40,000 (11%)	32,000 (9%)
Elkins Park, Pa.	385,000		28,000 (7%)
Salisbury, N. C.	332,000	37,000 (11%)	
Cairo, Ill.	305,000	58,000 (19%)	28,000 (9%)
Milwaukee, Wis.	160,000	30,000 (19%)	
Portland, Ore.	157,000	30,000 (19%)	
Shaker Heights, O.	394,000	52,000 (13%)	
Newtonville, Mass.	569,000	58,000 (10%)	30,000 (5%)
Average		14%	7%

This Week's Contracts—Week Ago—Same Week Last Year

The money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks.

Minimum costs observed are: $15,000 for waterworks and excavations, $25,000 for other public works, $40,000 for industrial and $150,000 for commercial buildings.

MONEY VALUE OF CONTRACTS LET—ENTIRE U.S.

Week Ending	Public Work	Private Work	Total Contracts
Jun11,1925	**$18,719,000**	**$26,235,000**	**$44,954,000**
Jun 4, 1925	22,617,000	28,752,000	51,369,000
Jun 12,1924	19,883,000	13,002,000	32,885,000
Heaviest Week			
1924, May 8	26,370,000	38,829,000	65,199,000
1925, Apr. 2	43,603,000	27,633,000	71,236,000
Jan. 1 to Date			
1925...	449,194,000	588,148,000	1,037,342,000
1924...	448,803,000	511,025,000	959,828,000

Engineering Construction Trend Toward Large Projects

Large engineering construction projects, in various stages of development throughout the entire country, to date, are considerably ahead of the correspondng period in 1924.

The gain continues in public as well as private work and is particularly noticeable in number and value of large privately owned commercial buildings.

Since the beginning of the current quarter, the number of big jobs has been unusually great.

Of the thirty-six largest projects, eighteen were valued at from $4,000,000 to $5,000,000 apiece; twelve, between $5,000,000 and $10,000,000 each and the remaining six ranged from $11,000,000 to $50,000,000 per project.

These jobs were taken in the various stages of development, namely, proposed, bids desired, bids received and contract awarded.

The six largest projects were: (1) A power plant, New York, N. Y., general contract awarded to Ken Well Contracting Co., $50,000,000; (2) water supply system, Oakland, Calif., plans prepared, $25,000,000; (3) office building, New York, N. Y., work to be done by separate contract, $18,000,000; (4) hotel, Chicago, Ill., awarded to G. A. Fuller, New York, $18,000,000; (5) subway, Philadelphia, Pa., awarded to Keystone State Constr. Co., $16,863,437; (6) sewers, disposal plant, etc., Toronto, Ont., proposed, $11,000,000.

In the *McGraw-Hill Daily Construction News-Service*, Jan. 1 to June 5, 1925, on three occasions, namely, Jan. 27, April 6 and May 28, the largest twelve projects of the day did not include a single job under $1,000,000. In seven other issues of the daily, during that period, eleven of the twelve largest jobs were for a million dollars or over. Each day, since Jan. 1, has had three or more valued in the millions.

Weekly Construction Market

THREE of the most reliable trade indicators continue to point in an upward direction. These are: construction, bank debits and freight loadings.

Construction, as measured by money value of contracts let, is at least 8 per cent ahead of a year ago to date.

Bank debits or check payments continue to gain in volume from week to week and are at present heavier than for the corresponding period in 1923 or 4.

Freight loadings for the entire country since Jan. 1 are notably in advance of those for a similar period in any year since 1921.

Prices of materials, particularly those used in construction, are tending downward; but gradually so. Price declines are only slightly in excess of advances.

Some firmness is apparent in such materials as cement and tile in the South, while weakness still prevails in certain items on the steel list in Western cities.

Recent weakness in pine lumber at New York is offset by a firming of the fir market in the Denver district.

Brick is slightly cheaper in San Francisco. The New York brick market, however, is affected by a strike in the Hudson River yards, which, while it has not caused an actual advance, is certain to result in scarcity and consequent rise in price.

No definite trend is shown by the linseed oil market; advances in one direction are promptly offset by declines in another.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.90	$4.15	$3.10	$3.35	$3.07½	$3.30	$3.35	$4.25
Structural rivets, 100 lb.	4.50	4.45	4.75	3.50	3.75	4.65	5.00	3.75	6.00
Reinforcing bars, ¾ in. up, 100 lb.	3.24	3.40	3.38	3.00	3.25	—3.62½	3.35	3.25	2.30
Steel pipe, black, 3½ to 6 in. lap, discount	48%	53.2%	43%	57%	54.25%	36%	39.2@51%	50%	59.49
Cast-iron pipe, 6 in. and over, ton	50.60@51.60	54.00	56.00	46.70@48.20	53.00	62.00	52.00	53.00	—55.00
Concreting Material									
Cement without bags, bbl.	2.50@2.60	+2.40	2.05	2.20	2.42	2.84	2.31	2.65	1.80
Gravel, ¾ in., cu.yd.	1.75	1.90	2.38	2.75	1.65	1.90	2.15	1.50	1.25
Sand, cu.yd.	1.00	1.40	2.00	2.75	1.25	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.85	2.00	2.83	2.75	1.75	2.50	2.15	3.00	1.90
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	—59.00	34.00	56.00	29.00@39.00	—38.75	+36.25	27.00	23.00	60.00
Lime, finishing, hydrated, ton	18.20	22.50	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl.	2.50@2.75	1.45	1.85	1.21	1.35	2.70	1.60	2.80	9.50
Common brick, delivered, 1,000	+18@19	10.50	12.10	12.00	13.50@13.60	12.00	—15.00	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	+ 0888	.10	.06	.....	.085	.....	.10	.12
Hollow partition tile 4x12x12, per block	1162	+ 0888	.10	.06	.07	.085	.108	.10	.10
Linseed oil, raw, 5 bbl. lots, gal.	1.09	—1.12	1.30	1.23	+1.17	+1.30	1.14	1.12	1.25
Common Labor									
Common labor, union, hour	.75	.30	.....	.87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	30@.50	.75	.50@.55	.35@.50	.50	.50	.25@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b.

Labor—Concrete laborers' rate, 93⅞c.; building laborers, 75c.; excavating laborers, 50c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of June 4, the next on July 2.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.10). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3½-in., $59.49.

Active Demand for Brick, Etc.

(*Concluded from p. 1000*)

last year. Advance orders as of May 1 show increased demand for brick in California, Illinois, Indiana, Wisconsin, New England, New York, Eastern Pennsylvania, New Jersey, Delaware and Maryland. Following is the report of the Common Brick Manufacturers' Association of America:

	Burned Brick on Hand M.	Unburned Brick on Hand M.	Brick Moved from Yards During Month M.	Orders on Books M.
1924				
May 1	238,703	58,972	169,855	382,778
1925				
Jan. 1	354,477	51,162	118,759	202,906
Feb. 1	279,862	23,951	94,185	201,479
Mar. 1	305,831	34,891	110,790	247,176
Apr. 1	287,800	43,446	170,697	329,673
May 1	281,858	71,266	206,551	339,629

Cement — The whole cement movement, involving production, shipments and reserve mill stocks, is considerably greater than a year ago, according to latest reports of the Geological Survey. The gradually increasing demand, started at the first of the year, will probably continue until October. Reserve mill stocks will necessarily decline proportionately during that period.